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FENWICK UMPLEBY

DESIGN TEXTS.

A Practical Treatise on
TEXTILE DESIGN, CLOTH CONSTRUCTION, FABRIC ANALYSIS AND CALCULATIONS.

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DESIGN TEXTS.

THE HAND LOOM.

The process of weaving, either on the hand loom or power loom, depends upon the same principles, with practically the same operations. The principal parts of the loom, such as the lay, which is used to beat up the filling; the reed, by means of which the warp threads are kept in their proper position; the heddles, used for the separation of the warp threads; the harnesses, by which the weaving of the design is controlled; the leese rods, used to keep the warp threads parallel to each other, all vary but little in either loom. The shuttles are similar, and the warp and cloth beams serve the same purpose. The quality of work differs but little, although the production of the power loom exceeds that of the hand loom. This is due to the fact that the driving of a loom by power allows more picks to be introduced into a fabric in a given time than is possible by the hand and foot power of a hand loom.

Weaving was practiced by the Egyptians, although little is known of their looms or the manner in which they prepared yarn for the loom. The discovery of a few wall paintings at Thebes, among which were representations of the Egyptian methods of weaving and spinning, gives us our first knowledge of ancient looms. One method was to weave the fabric in a horizontal position, in fact, on the ground, the weaver sitting on the woven fabric. Vertical looms were also used, the weaver throwing the filling through the shed by means of a rod. On the end of this rod was a hook, to which the filling was attached. Two weavers were frequently employed, sitting at either side of the loom, passing the rod back and forth through the shed.

The Greeks and Romans used vertical looms similar to the Egyptian. The cloth was woven upwards, the warp being suspended from the top beam of the loom, and the lower ends tied in separate portions and weighted to keep the threads in tension. The filling was combed into position by means of a comb adapted for the purpose.

The present hand loom is made upon the principle of the ancient hand loom of India. Rude in construction as it was, the Indian hand loom was capable of producing the most delicate muslins, cloths, shawls, and similar fabrics. The "mulmul khas," or King's muslin, was so delicate that a specimen of cloth ten yards in length and one yard in width, containing 1900 threads in warp, could be passed through a small ring. The fabric weighed 182 grains to the yard, or approximately 38.5 yards to the pound. The yarn used was equal to 185s cotton.

The hand loom was constantly improved until 1773 A.D., when the first attempt to drive a loom by power was made at Glasgow, Scotland, a Newfoundland dog working in a race wheel furnishing the required power. The number of inventions for the hand and power looms is so great that it is almost impossible even to list them. The principal events in the development of the loom of the present time are:

1199 Cloth manufactured at Nottingham, England.
1307 Linen manufacture established in England.
1510 Broad looms adopted.
1589 Ribbon loom invented by the Dutch.
1667 Gobelin manufactory established at Paris.
1676 Dutch engine loom introduced into England.
1678 M. de Gennes presented his model of a "machine for making woolen cloths without the aid of a workman."
1687 Joseph Mason obtained a patent for an engine by the help of which the weaver may do without the draught boy.
1725 M. Bonchon invented the use of perforated paper for working the draw loom. This is considered the origin of the Jacquard.
1728 M. Falcon substituted a chain of cards to turn on a prism in place of the perforated paper of M. Bonchon.
1745 John Kay and Joseph Stell obtained a patent for applying tappets to the Dutch engine loom.
1745 M. Vancanson applied the griffe to M. Falcon's invention, placing the apparatus on the top of the loom.
1760 Joseph Stell obtained a patent for the application of "sundry tappets" for weaving figures in the Dutch or narrow loom.
1785 Dr. Cartwright obtained a patent for a vertical loom.
1786 Dr. Cartwright obtained a patent for a "weaving machine," or loom, in which warp and filling motions were first attempted.

1787 Dr. Cartwright obtained a patent for improvements in his power loom. These comprised a spring picking motion, a stop motion when shuttle fails to enter box, temples, plyers, etc.

1788 Dr. Cartwright applied cams for variable motion to the batten.

1792 Dr. Cartwright obtained a patent for a change shuttle box, an engine for raising a pile, and circular knives for cutting the pile.

1796 Robert Miller patented the "wiper" power loom, so called from the driving of the picking and treadle motions by cams, or "wipers."

1801 Jacquard exhibited his loom at the French Exhibition.

1802 Redcliffe invented the "Dandy Loom."

1805 Johnson and Kay patented revolving temples, and applied projections on picking cams.

1812 The weaving of three-ply carpets patented by Thomas Lee.

1834 L. and J. Smith patented a method of picking from the crank shaft, which was the forerunner of the scroll pick.

1835 John Osbaldston patented the manufacture of heddles from twisted brass wire.

1841 Kenworthy and Bullough patented a roller temple and a filling stop motion, both in present use.

1842 A method of weaving velvet or looped surfaces patented by R. W. Sevier.

From 1842 to the present time the number of improvements has increased wonderfully, resulting in the present almost perfect power loom. The hand loom, although still used in many countries, is being steadily replaced by the more productive power loom.

HARNESS, HEDDLES, AND EYES OR MAILS.

Before commencing the study of Textile Design, some knowledge of the principles and working of a hand loom should be obtained. The first step in this direction is to consider the arrangement of the warp threads in the heddles or the harnesses, or, as it is termed, "warping and dressing," and the next will be the method of actuating the harnesses by means of a chain, or the order in which they are arranged to produce the required pattern.

In this, as in all other work, there must be some recognized means of conveying or indicating the order in which the threads must be drawn through the harness.

When the weaver is standing in front of the loom, whether hand or power, the harnesses are in front of him, as in Fig. 1,

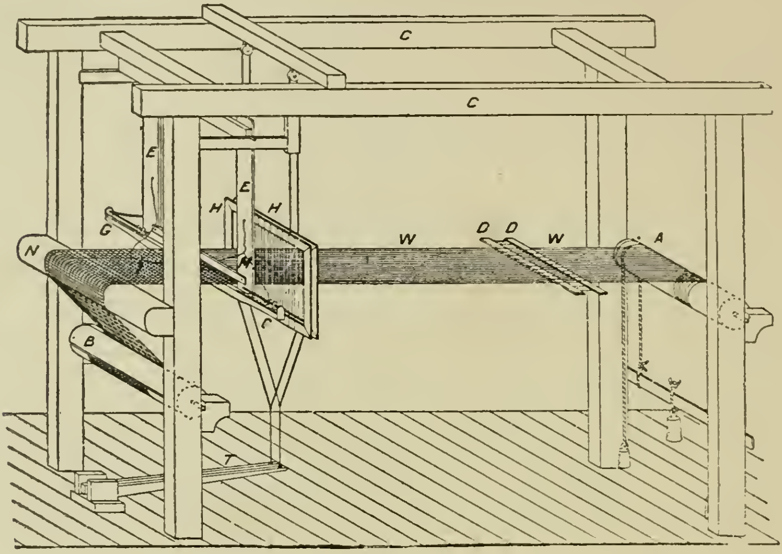


Fig. 1.

which represents a common hand loom, such as is adapted for plain weaving. It consists of four wooden posts framed together at the top by two long cross pieces. The two long pieces C C are called the capes of the loom. Between the two pairs of posts, forming the ends of the loom, are placed two cylindrical beams, the beam A being the warp beam, upon which the warp is wound, and B the cloth beam, upon which the cloth is wound as it is woven.

The warp threads are placed parallel to each other, as before described, and are carried from the warp beam A and attached to the cloth beam B. This is done by threading the knotted ends of the threads upon a small rod, and wedging it into the slot or groove formed in the beam for that purpose, as shown at X in Fig. 2.

In order to keep the threads in their relative positions and parallel to each other, two rods D D are inserted between the warp threads in such a manner that each thread passes over one of the rods and under the other alternately, as shown. Thus a cross or leese is formed by the threads between the two rods, which not only keeps the threads in proper order, but enables the

weaver to detect with ease the proper position of any broken thread that he may have to repair. This arrangement of the threads is formed during the process of warping, or warp dressing, and slashing.

After the warp has passed the leese it is then passed through

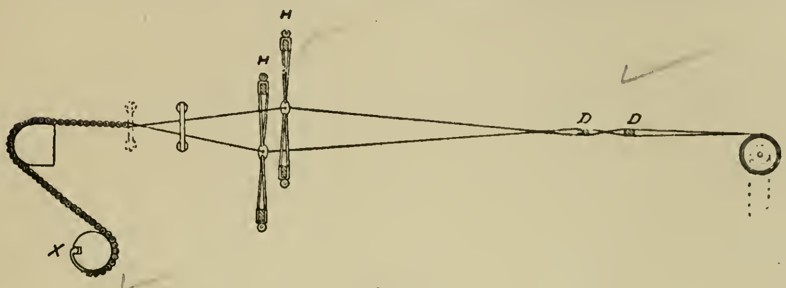


Fig. 2.

the heddles, as shown at H in Figs. 1 and 2. The heddles are composed of a number of threads or wires threaded between laths or harness shafts. Each wire or thread has a loop in the middle, or, instead, an eye, called a mail or heddle eye, is threaded upon it, through which the warp thread passes. There are two heddles shown at H H, one of which receives every alternate thread of the warp, and the other receives the remainder. Consequently, if either of them be raised, it will also raise the warp threads which have been threaded through the heddle eye or mails.

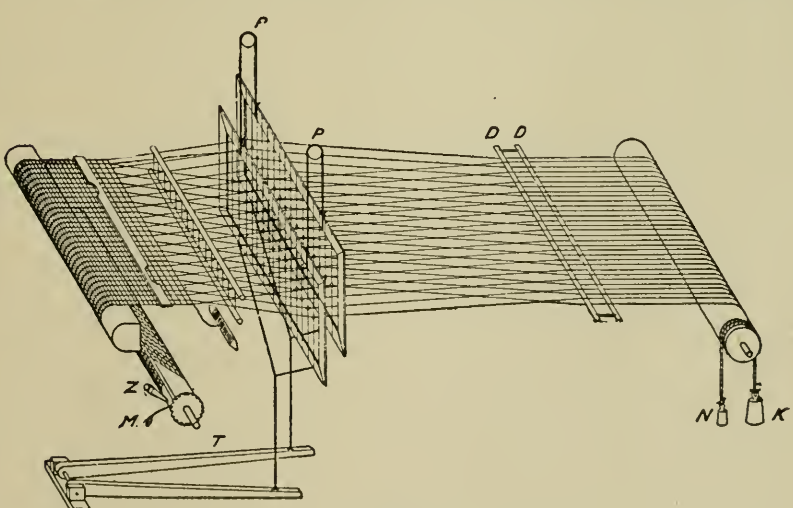


Fig. 3.

The arrangement of the warp threads, and the various parts of the loom which operate them, may be best understood by referring to Fig. 3 on page 7, which is a diagram showing each warp thread separately.

In Fig. 3 the harness shafts are shown connected and balanced by cords passing over pulleys, P P, and the lower part attached to the treadles T. The right treadle is shown depressed, consequently it raises the other treadle and the harness. Thus half of the warp can be alternately raised for the passage of the shuttle.

The warp is kept in tension by means of weights connected to a rope passing once or twice round the warp beam. The cloth beam is provided with a ratchet wheel and pawl M, also with a handle Z, for winding on the cloth as it is woven.

In Fig. 3 only one each of the leeses is shown, but as there must be one to each pair of warp threads, the required number must be provided for. Thus, if there are 500 threads per inch in the width of the cloth, there must be 250 leeses per inch in the warp, or 250 threads per inch on each harness. But as the heddles are composed of material much thicker than the warp threads, they necessarily take up more room, and could not be placed upon one pair of harnesses in weaving fine warps. In such cases more harnesses are used, each having its share of the threads, and half of them are raised at once, so as to raise one-half of the warp threads.

THE HAND LOOM.

1. How do the principles of weaving on the hand loom and power loom differ?

2. Give the uses of the following parts of a hand loom:—The lay, reed, heddles, harnesses, leese rods.

3. How does the production and quality of work of a hand loom compare with that of the power loom?

4. What is the warping and dressing?

5. What are the uses of the warp and cloth beams?

6. Give a short description of the construction and uses of heddles.

7. Make a diagram showing the arrangement of the warp threads, and the various parts of the loom which operate them.

8. Make a sketch showing the lifting of a harness by the treadle.

9. How is the warp kept in tension? Illustrate by a sketch.

THE DESIGN PAPER.

There are three primary elements in textile design: 1st, the weave; 2nd, amalgamation and combinations of weaves and form; 3rd, the mixing and blending of colors as applied to textile fabrics. These three elements, either separately or connectedly, are the principal factors in all woven fabrics.

The object to which a design is to be applied is of the utmost importance; the designer must know the uses to which the fabric is to be applied and the purposes it is intended to serve. Searching the dictionaries as to the true meaning of "design," we find that, in its broadest sense, "design" is a sketch or a plan. But this interpretation of design as applied to cloth construction is not all that is necessary. When an architect draws the plan of a house, a draughtsman the plan of a machine, or an engineer the plan of a bridge, he first studies out the convenience of arrangement, the conditions as to strength, durability, and utility, and other requirements which are necessary to the purpose to which they are to be applied, and it is indispensable that all these particulars be considered in their entirety. Therefore, a textile design, or the design of a woven fabric and its specification when complete, is a perfect working plan, descriptive and illustrative of the arrangement and character of all the component parts and processes. It describes the different materials, as to quality and kind, character, size, and color of the yarn, gives the arrangement of the threads, also quantities and proportions. The design illustrates the construction of the fabric, and the specification, or lay out, describes special processes and operations. To be complete and perfect, it should be so comprehensive that any qualified manager could produce the desired fabric from it without any further instructions. If it is required that working plans for a house, machine or bridge should be produced with neatness and precision, surely these requisites are much more necessary in a textile design, which should be made with a perfect knowledge of that which pleases the eye; in fact, all of which should combine to produce an artistic piece of work.

We commence our studies, therefore, with a faint idea of what a design should consist, but assuming ourselves to be ignorant of the whole subject, so that the detail and elementary princi-

ples can be dealt with and their practical application shown in the simplest manner.

USE OF SQUARED, DESIGN, POINT OR RULED PAPER.

This paper is ruled so as to represent a series of squares surrounded by a heavy line. These squares are again divided by fainter or smaller lines into eight or more squares, as shown in Fig. 4.

The use of ruled paper is a mystery to the majority of people, although it is exceedingly simple when the first rudiments and principles are understood. To have a clear and proper conception of the use of design paper, it will be necessary for the student to divide the squares into two distinct systems. First, to suppose that there are a series of vertical and no horizontal lines. Second, that there are a series of horizontal and no vertical lines.

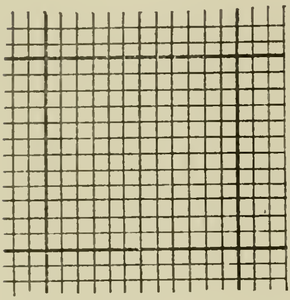


Fig. 4.

It is universally understood that woven fabrics in general have two systems of threads; first, the warp threads; second, the weft or woof; the weft is commonly called the filling. These are the two requisite things to form the plainest or most elaborate woven cloth.

WHAT IS THE MEANING OF WARP AND FILLING?

Warp is the set of threads that runs lengthwise in woven goods, or the longitudinal threads that are drawn through the harness and reed which face you when you are looking at a loom that is weaving a fabric. Warp is represented on the design paper by the vertical or perpendicular series of small squares.

The weft or filling is the set of threads put in by the shuttle, and runs from one side of the cloth to the other, interlacing the warp at right angles, and is represented on the white board or design paper by the transverse or horizontal series of small squares. It should be clearly understood that these two systems, warp or vertical squares, Fig. 5, filling or transverse squares, Fig. 6, form the fabric or design. The object of point paper designing is to reproduce an imitation of the cloth and to show the method of interlacing in the fabric.

The error that is usually made by beginners is that each square is thought of by itself, without taking into consideration that each line of squares, either vertical or horizontal, forms the design.


Fig. 5. Warp.

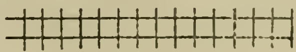


Fig. 6.—Filling.

Another object of the ruled paper is to enable the designer to show a plan of the fabric exactly as it would appear when looking down upon it. This will be more readily understood by an examination of Fig. 7, plain weave, which may be woven on two harnesses. This is always called the plain or cotton weave. The black and colored pegs on the design board, or marks, crosses or dots on the design paper, will always represent the warp threads raised, unless otherwise specified.

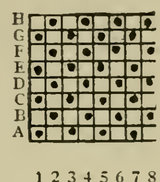


Fig. 7.
Plain Weave.

In this weave there are only two movements, one up and one down; the threads of the warp are drawn through the harness as follows: First thread through the eye of the first heddle on the front or first harness; second thread through the eye on back or second harness. This operation is repeated over and over again, until the whole of the threads of the warp are drawn through the harnesses. The 1st, 3rd, 5th, and 7th are drawn on the front harness, and the 2nd, 4th, 6th, and 8th are drawn on the back harness. The harness may be increased to 4, 6, or 8, or any even number, to the capacity of the looms, and in accordance with good judgment as to the crowding of the threads in the loom.

Fig. 8 is a sketch of the enlarged section of a fabric woven on this principle; it is a simple interweaving of one thread alternately over the other.

First thread or harness up and second thread or harness down. A pick of filling is now put in and the loom changed to the second pick. By inspection a filling thread is seen to be laid, under the 1st, 3rd, 5th and 7th threads and over the 2d, 4th, 6th and 8th threads. A second pick is put in and the lay of the loom swung over the next pick. Now the filling thread is laid over the 1st, 3d, 5th, and 7th threads and under the 2d, 4th, 6th, and 8th threads; the third pick will be like the first and the fourth pick will be like the second. These two movements are repeated over and over again until the web or warp is woven

out. This constitutes a plain weave, and the appearance of the enlarged diagram, Fig. 8, is somewhat like the interlacing of the strips of willow in the making of baskets and mats. The two systems of threads cannot be seen at the same time in the

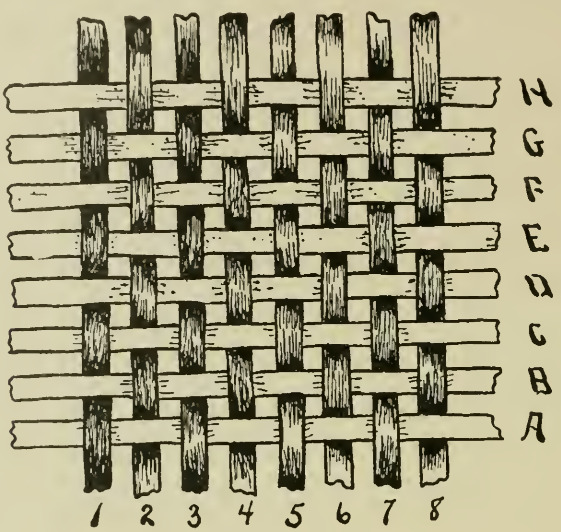


Fig. 8.—Diagram.

same position on the surface on the cloth, that is, when a filling thread is seen on the surface, the warp over which it goes must be covered; thus, if a black pick goes over a white thread it is the black pick that is seen on the surface of the fabric and covers the white warp from view.

Explanation of weave, Fig. 7. Notice that on the first thread the black represents warp raised, and the second thread has no mark which signifies that this thread is depressed; note that the 3d and 4th, 5th and 6th, 7th and 8th are repetitions of the first and second threads.

Now examine the filling, A and B, Fig. 7.

A is represented as interlacing under No. 1 and over No. 2, under No. 3 and over No. 4, under No. 5 and over No. 6, under No. 7 and over No. 8. B is represented as interlacing over No. 1 and under No. 2, over No. 3 and under No. 4, and so on. C and D, E and F, G and H are repetitions of A and B. To thoroughly understand the use of design paper, the main fact to be borne in mind is the continuity of every

individual thread, either in the warp or filling; and in making a design the leading consideration is that it shall be so arranged, that whatever the pattern, it shall be continuous and unbroken, on the same principle as when we cover our walls with paper, or floor with carpet. the pattern must join perfectly and be continuous, or the broken, irregular pattern will offend the eye.

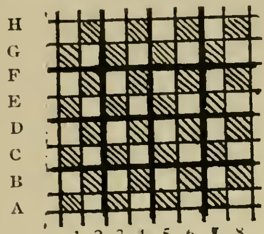


Fig. 9.
Plain Cloth, Four Repeats

How this affects the design will be best understood by a close study of Fig. 9. Nos. 3 and 4 are a repetition and continuation of 1 and 2, 5 and 6, of 3 and 4, and 7 and 8, of 5 and 6, and so on. Fig. 8, as previously stated, is an enlarged section of the woven fabric on the plain or cotton cloth weave.

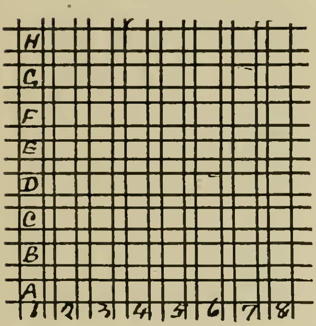


Fig. 10—Formation of Design Paper

Fig. 10 illustrates the principles of the vertical and transverse lines and construction of the point paper. The vertical stripes in Figs. 9 and 10 correspond with the warp threads No. 1 to No. 8 in Fig. 8, also the transverse stripes A to H correspond with the filling threads A to H in Fig. 8. From this it will be seen that each warp thread has a strip of squares and that each filling pick has a strip of squares on the design paper. If point paper was ruled after the manner of Fig. 10, it would be difficult to see a pattern at a glance, as the profusion of lines would be confusing. To overcome this the paper is ruled without the spaces between the threads, as shown on Fig. 10, but the spaces are represented with lines as in Fig. 4. So we must understand that the lines do not represent threads, but indicate the divisions between the threads, and it is this that enables an accurate plan of cloth to be made.

When this strip arrangement is fully understood, the first principles of design will be readily overcome.

POINTS TO BE REMEMBERED

First—The small lines represent places of intersection.

Second—A mark, cross, or dot on one of the small squares indicates that such thread is raised—the filling is under and the warp on the surface.

Third—An empty space or small square represents that the filling is on the surface, thereby covering the warp.

Fourth—That the black lines do not represent threads and picks, but indicate divisions between them.

Fifth—That the pattern must be continuous and unbroken.

PLAIN CLOTH.

A plain cloth makes a very strong and firm texture, but it is not a very close or heavy fabric. The threads do not lay as close or compact as in other weaves. If a plain cloth is not fulled or shrunk in the finish, it is perforated to a more or less degree, according to the size or twist of yarns used. These perforations vary greatly under different conditions; if very heavy or coarse threads are used, the perforations will be large; if finer threads are used, the perforations will be smaller. There are other conditions which may alter and change the texture of the plain weave.

Fig. 11. Cut Section

If the threads are twisted hard, the result is a wiry and open cloth, but if the structure is studied, yarns are made according to the requirements and the fabric brought to a closer and more compact texture. There is an important matter in the selection of yarns, that is, the direction of the twist. It is noticed that when two pieces of heavy cord or rope, of the same twist, are twisted together, they will interlay or become imbedded with each other, but if ropes of contrary twist are twisted together, they do not lay close or compact and there are large perforations. This is because the ridges of the twist cannot lay compact. These are some of the first and important considerations which we should not forget in the construction of our first plain cloth.

So far, we have been studying the rudiments and foundation of a true plain fabric, that is, a fabric where the warp and filling are equal, both as to size of yarn, number of threads, and picks per inch.

THE DESIGN PAPER.

1. Describe and illustrate the ruling of design paper.
2. Define the term "warp."
3. (*a*) How is warp represented on design paper?
   (*b*) How is warp placed in the loom? Describe fully.
4. Define the term "filling."
5. (*a*) How is filling represented on design paper?
   (*b*) How is filling placed in the loom? Describe fully
6. What is the object of point paper designing?
7. What forms the design on design paper?
8. What is the plain or cotton weave?
9. How many harnesses are required for the plain weave?
10. What do the black or colored squares on design paper represent?
11. Give a complete description of the drawing-in of the first and second threads of plain weave.
12. Which threads in a "repeat of eight" in plain weave are drawn in on the front harness? On the back harnesses?
13. Do the number of harnesses used in plain weave ever exceed two? If so, why?
14. What is a diagram?
15. Make a diagram of plain or cotton weave (six threads and six picks).
16. Describe fully the weaving of the first pick in plain weave.
17. Describe fully the weaving of the second pick in plain weave.
18. How does the third pick differ from the first and second picks?
19. How does the fourth pick differ from the first or second picks?
20. Can the two systems of threads (warp and filling) be seen in the same position on the surface of the cloth? State your reasons.
21. Describe the weaving of the first thread in plain weave.
22. Which threads weave over the first pick in a repeat of eight?
23. Which threads weave under the second pick in a repeat of eight?
24. Describe the continuity of a pattern.

25. What is the necessity of a continuous pattern? Illustrate by the cotton weave.

26. (*a*) What is the principle of the vertical lines on design paper?

(*b*) What is the principle of the horizontal lines on design paper?

27. Describe the principles of the construction of design paper, explaining the meaning of the lines and spaces.

28. How are the divisions between the threads shown on design paper?

29. State what the following denote on design paper:—Small lines, crosses, an empty space.

30. What is the effect of a pattern which is not continuous?

31. Describe the texture of a plain cloth.

32. Compare the threads of a plain weave with other weaves in regard to compactness.

33. What is the appearance of a plain cloth if not subjected to fulling?

34. Compare two plain cloths, one woven from coarse yarn, the other from fine yarn, the finishing processes being omitted.

35. What is the effect of a hard twisted yarn in plain cloth?

36. Compare the texture of two plain cloths, one woven from yarns of similar twist, the other from yarns of contrary twist.

37. Which of the cloths in question 36 will be the more compact in texture?

38. Make a cut section of the first pick of a plain cloth.

39. What are the three primary elements in textile design?

40. Define the word "design."

41. What are the principal requirements of a design?

42. Give the particulars required for a specification of a complete design.

43. What specifications must be made regarding yarns when designing a textile fabric?

44. Is art considered of any importance in textile designing?

45. Name five cloths woven from plain weave.

TWILLS AND DIAGONALS.

After the plain weave has been thoroughly understood, the next step is a study of twill weaves. These are weaves in which the intersections of the warp and filling threads are such that they produce lines diagonally across the fabric, either from right to left or from left to right, at an angle of 45 degrees. The

simplest twill weave that can be constructed is one for three harnesses, variously known as the 3-harness twill, prunella twill, and 3-harness doeskin. These names vary according to the nature of the material or the relations of warp and filling employed in the construction of the particular kind of fabric referred to.

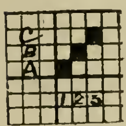


Fig. 12.

Fig. 12 is an illustration of this simple twill weave. It shows the three different positions of the threads to form the twill, and, as in plain cloth, it must be observed that whenever the warp is raised an indication is made in the corresponding small square on the design, and thus denoting which thread is elevated when the filling pick or thread is inserted.

Fig. 13 shows an enlarged diagram of a fabric woven upon this principle. It will be noticed that the warp thread No. 1 is raised, as indicated by the mark in the small square at the left-hand lower corner in Fig. 12, the first pick A passes under it and over Nos. 2 and 3. On the second pick the mark is on the second thread, consequently the filling thread B passes over No. 1, under No. 2, and over No. 3. And on the third pick the mark is on the third thread, therefore the third filling thread passes over Nos. 1 and 2 and under No. 3.

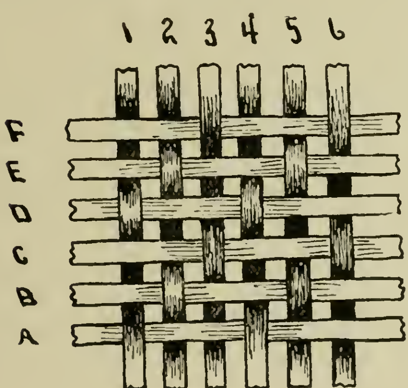


Fig. 13.

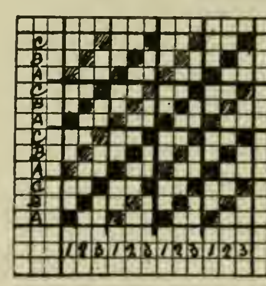


Fig. 14.

Fig. 14. In this design the pattern is complete within a given space, and it makes no difference to what proportions the design may be extended, it will be a continuous and unbroken repetition of the first three threads, Nos. 1, 2, 3, also the first three picks, A, B, C, as shown in design No. 14. If Figs. 14 and 15 are examined, the conditions are quite opposite, and it will be noticed

that it is a simple reversal of the twill, that is, the warp is elevated two threads of the complete design, viz.: the first two threads are raised as indicated by marks, while the third thread is depressed—exactly the reverse of Figs. 12, 13, 14.

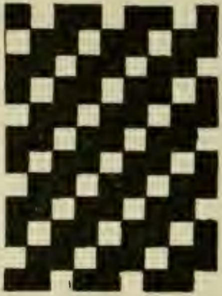


Fig. 15

In these examples every three threads and picks are an exact repetition of the first three, and any number of threads may be taken from one side and placed on the other side, or they may be taken from top or bottom. The twill is continuous and unbroken

In the absence of design paper there are other ways of indicating a weave. Take the plain weave as the first example: It can be stated thus: $\frac{1}{\quad 1}$ or written 1 up and 1 down.

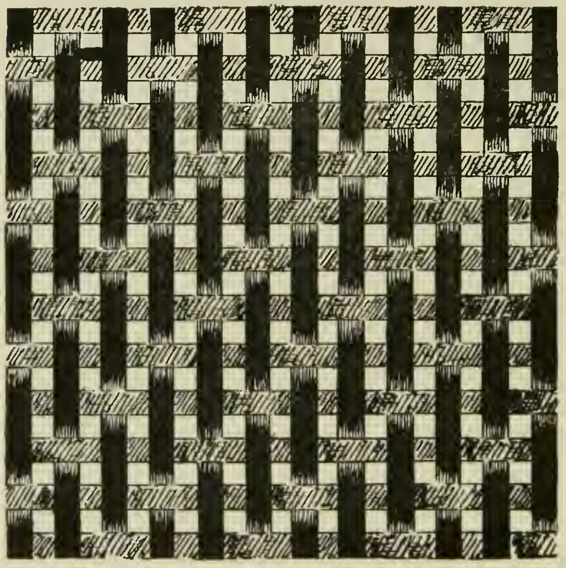


Fig. 16

Second example. The 3 harness prunella twill, filling flush, or 1 up and 2 down or $\frac{1}{\quad 2}$.

Third example. The 3 harness doeskin twill, warp flush, or 2 up and 1 down, or $\frac{2}{\quad 1}$.

The word up, or figure above the line, indicates the number of threads to be raised on each pick, while the word down, or figure below the line, signifies that such threads must be depressed for the filling to pass over.

Twills are divided into two classes, those which are even-sided and those which are uneven. The even-sided twills are those where the warp and filling are evenly balanced. By examination of Fig. 17 and Diagram 18, it will be noticed that

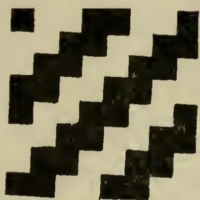


Fig. 17

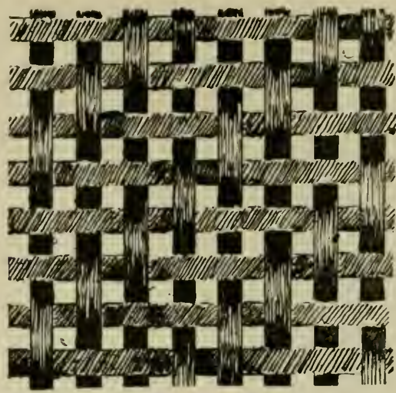


Fig. 18

the number of threads raised are equal to the number of threads depressed, that it is a 4-harness twill, and that each succeeding four threads and picks are a repetition of the first four. The line of twill is continuous and unbroken. This weave is called the 4-harness common twill, cassimere or shalloon twill. The written formula is 2 up and 2 down, or $\frac{2}{2}$

The uneven-sided twills are of two kinds—those on an even number of harness and those on an uneven number of harness. Fig. 19 is an uneven-sided twill on an even number of harness, representing the 4 harness swansdown, having three-fourths of the filling on the surface. Formula, $\frac{1}{3}$. The reverse of this weave would be $\frac{3}{1}$, and indicating the warp surface weave, commonly called the crow weave.

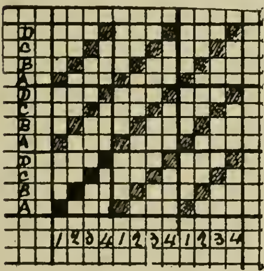


Fig. 19

Fig. 20 represents an uneven-sided twill on an uneven number of harnesses. On this weave it will be noticed that there are only two threads raised, while there are three depressed. Formula, $\frac{2}{3}$. This weave can be reversed so that the conditions would be opposite. Formula, $\frac{3}{2}$.

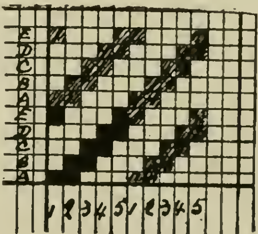


Fig. 20

Attention is again called to the angle of the twill. It is continuous and unbroken and at an angle of 45 degrees. In designing twills always begin at the lower left-hand corner of the design and make out the angle of the twill for the full number of the threads, both for the warp and filling. Thus, a full weave of an 8-harness twill will require eight threads and eight picks and eight small squares each way of the design paper.

Each design should be carried to fully twice the original number of threads and picks. Study each side, top and bottom. Also study the termination when a pattern is complete. The number of threads and picks to complete the design should be seen at a glance and in repetition it should be continuous and unbroken.

Fig. 21 *First Pick*

Fig. 22 *Second Pick*

Fig. 23 *Third Pick*

Fig. 24 *Section of the 3 picks combined*

Fig. 21 is a cut section of the first pick of weave in Fig. 15.

Fig. 22 is a cut section of the second pick of weave in Fig. 15.

Fig. 23 is a cut section of the third pick of weave in Fig. 15.

Fig. 24 is a cut section showing the three picks as they would appear in the cloth, Fig. 15

Fig. 25

Fig. 25 is a cut section of the first pick of weave in Figs. 17 and 18.

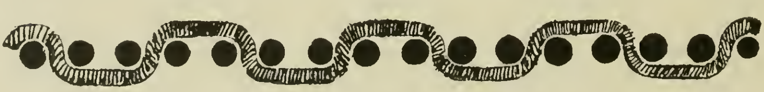


Fig. 26

Fig. 26 is a cut section of the second pick of weave in Figs. 17 and 18.

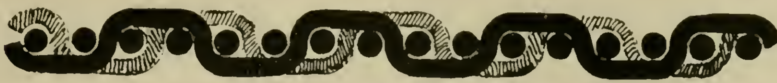


Fig. 27

Fig. 27 is a cut section of the first and second picks combined of Figs. 17 and 18.

TWILLS AND DIAGONALS.

1. What is a twill weave?

2. What angle of degree is most commonly used for twill weaves?

3. (a) What is the simplest twill weave that can be constructed?

(b) Give the various names for this weave.

4. Make a diagram of two repeats, warp and filling of the weave named in 3b.

5. Should twills be broken or continuous in the repeat? State the reason for your answer.

6. Make a design for a warp flush, 3-harness twill.

7. How does the weave in question 6 compare with the weave in question 4?

8. In the absence of design paper, how are the following weaves expressed:—Plain, 3-harness twill warp flush, 3-harness twill filling flush?

9. Define the terms "up" and "down."

10. Name the two classes of twills, giving an example of each.

11. Make a complete design and diagram of the cassimere twill.

12. Give the various names used for the cassimere twill, and show how this weave may be expressed in the form of a written formula.

13. Make designs for the swansdown and crow weaves.

14. Give written formulæ for weaves in question 13.

15. (a) Make a design two repeats warp and filling of the $\frac{3}{\quad 2}$ twill.

(b) To what class of twills does this weave belong.

16. Give the method in full for designing a twill, using as an example the 3 up and 3 down twill.

17. What is the advantage in carrying out twills to twice their repeat warp and filling? Describe fully.

18. Make cut sections of the first pick, second pick, third pick, and first, second and third picks combined of the 2 up, 1 down twill.

19. Illustrate by cut sections the difference between the prunella and shalloon twills.

20. Make designs for each of the following weaves:—Prunella, doeskin, swansdown, crow, cassimere and basket.

INTERSECTIONS, INTERLACING, INTERWEAVING, AND CUT SECTIONS.

What is the meaning of intersecting, interlacing, and inweaving? Take the plain weave for an example, $\frac{1}{\quad 1}$. If a number of threads are taken and the 1st, 3d, 5th, 7th, and so on lifted and the 2d, 4th, 6th, 8th, and so on depressed, and between these sets of threads a pick of filling is introduced, we should be interlacing or interweaving the warp threads. What would be the result? Figure 28 illustrates the section of eight warp threads in a plain cloth, interwoven with one pick of filling, A. We have 1st thread, then an intersection of filling; 2d thread, then intersected by filling, thus: 1st thread and one intersection, 2d thread and one intersection.

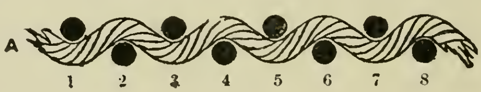


Fig. 28

The answer to the above question is: Interlacing and interweaving is inserting the filling between two or more systems of warp threads, while the intersection is the space occupied by the warp or filling between any number of threads, warp, or filling. On the design paper the spaces represent the warp and filling, while the lines represent the intersections.

Take the next example, the three-harness weave, $\frac{1}{\quad 2}$: one thread up and one intersection, two threads down and one intersection.

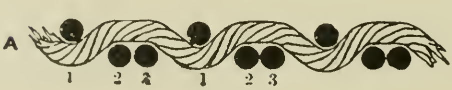


Fig. 29.

Now examine the cassimere or shalloon twill, $\frac{2}{\quad 2}$. Notice

that the filling thread interweaves alternately over and under two warp threads, and in the same order the warp threads interlace over and under two filling threads.

Fig. 30

By studying the weave, $\frac{2}{2}$ twill, it is found that each succeeding filling thread does not pass over the same two warp threads, nor does each consecutive warp thread interlace over or under the same two filling threads, nor are they alternate as in plain cloth, but each change in regular consecutive order. The first pick, A, interweaves over the threads Nos. 1 and 2, and under Nos. 3 and 4; the 2d pick, B, passes under No. 1, over Nos. 2 and 3, and under No. 4; the 3d pick, C, passes under Nos. 1 and 2, and over Nos. 3 and 4; the 4th pick, D, passes over No. 1, under Nos. 2 and 3, and over No. 4. The 5th pick is a repetition of No. 1 and so on. The design is continuous and unbroken, each thread and pick advancing one before it rises to the surface or passes to the back of the fabric.

Fig. 31.

It is this order of interlacing that has the effect of producing in the cloth distinct twills or diagonal lines at an angle of 45 degrees.

This mode of interweaving is called the even or balanced system. There are, as in the plain weave, as many of each system of threads on the face of the cloth as there are on the back. The longer the intervals that the warp and filling are interwoven and interlaced, the more material may be introduced to gain weight and substance.

Examine the three weaves under consideration. Plain weave—one up and one intersection, one down and one intersection, or two threads and two intersections. As shown in the lessons on the plain weave that when constructed on the truest principles, warp and filling of the same size, and the number of threads and picks per inch being equal, it will make a cloth more or less perforated according to the material used. The fabric would be built to withstand wear, tear, and friction, but bulk and compactness could not be obtained. Examine the three-harness twill, $\frac{1}{2}$. There are two intersections

Fig. 32

in every three threads, one up and one intersection, two down and one intersection, allowing threads Nos. 2 and 3 to lie close together without any perforations.

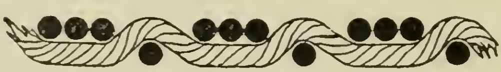
In the four-harness, $\frac{2}{\quad 2}$ cassimere twill, there are only two intersections on every four threads. Two threads up and one intersection, and two threads down and one intersection, thus giving still more opportunity to gain weight and compactness of texture, as an examination of the cut section No. 33 will show—in the first pick, the first and second threads are lying together side by side, then an intersection, third and fourth threads lying together, then an intersection, and so on, consecutively and continuously. The three weaves on twelve threads and their intersections stand as follows: Plain weave Fig. 34, 12 threads, 12 intersections; three-harness twill Fig. 32, 12 threads,

Fig. 33.

Fig. 34.

8 intersections; cassimere twill Fig. 33, 12 threads, 6 intersections.

Take another example: The four-harness filling flush twill commonly called the swansdown weave: one up and three down, or the warp flush crow weave, $\frac{3}{\quad 1}$. In these two weaves there are only two intersections on four threads, and there are three warp threads lying close together, either on the face or back of the cloth. These weaves give more liberty to use heavier material or a greater number of threads in the warp or filling, according to the weave used.



Warp Flush.
Fig. 35.

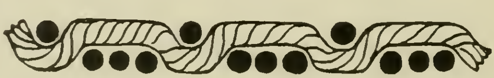


Fig. 36—Filling Flush.

These are items that must be considered when designing textile fabrics.

INTERSECTIONS, INTERLACINGS, AND CUT SECTIONS.

1. What is interlacing and interweaving?

2. What is an intersection?

3. Define the term "cut section," illustrating by a cut section of a pick of filling weaving plain with eight warp threads.

4. How is an interlacing represented on design paper?

5. How is an intersection represented on design paper?

6. Make a cut section of the first and third picks of the $\frac{1}{\quad 2}$ twill.

7. What is a cassimere or shalloon twill?

8 Make a cut section of the first and third picks of the cassimere twill.

9. How does the third pick in the cassimere twill differ from the first?

10. Make a cut section of the first thread of the cassimere twill.

11. Describe the interweaving of the first four picks of the cassimere twill.

12. Give the method of producing a 45° twill, illustrating by the $\frac{1 \quad 2}{2 \quad 1}$.

13. What is the even, or balanced system of interweaving? Describe fully.

14. How is weight and substance gained in the even system of interweaving?

15. How do two fabrics, one woven plain, the other 2 up, 1 down twill, compare in regard to weight and compactness?

16. Compare the fabrics in question 15 with a fabric woven cassimere twill, for weight and size of yarn.

17. How many intersections are there in twelve threads each of the three weaves in questions 15 and 16?

18. Describe the difference between a warp flush and a filling flush weave.

FANCY DEGREE TWILLS.

The student must not confine himself to what are commonly known as simple twills, but should find out how many designs

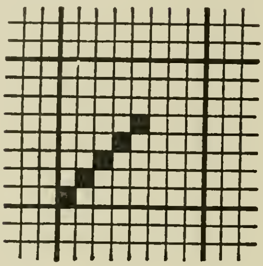
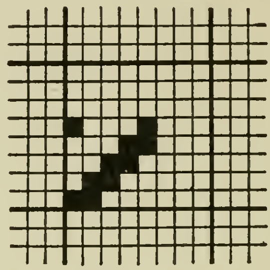


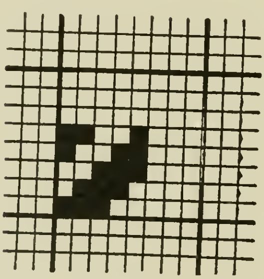
Fig. 37. 1/4



2/3 Fig. 38.

and what variety he can produce upon a given number of threads. The best plan in going about this work—and this holds good in every branch of the work—is to proceed in the most systematic manner.

For instance, take five threads as a base and work out as



3/2 Fig. 39.

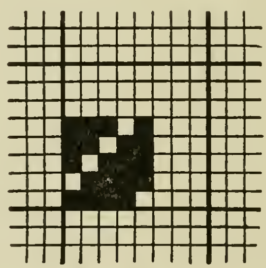


Fig. 40.

many regular twills as possible. These are given in Figs. 37, 38, 39, 40, 41, and 42, which show the full limit in producing what are commonly known as "regular twills" on five harnesses.

This expression "regular twills" must be understood, as it is in the trade, to apply to twills running at an angle of 45 degrees, and with no fancy figure accompanying it.

It will be noticed that all 45-degree twills move or advance 1 thread to the right until the full repeat of the weave has been obtained and can be worked out from a written formula, thus: Fig. 37, $\frac{1}{\quad 4}$; Fig. 38, $\frac{2}{\quad 3}$; Fig. 39, $\frac{3}{\quad 2}$; Fig. 40, $\frac{4}{\quad 1}$; Fig. 41, $\frac{2 \quad 1}{\quad 1 \quad 1}$; Fig. 42, $\frac{1 \quad 1}{\quad 1 \quad 2}$. These examples refer to the first pick of each design, which is a 45-degree twill, but when the twill is irregular there must be another method of indicating the weave.

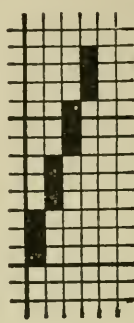


Fig. 43.

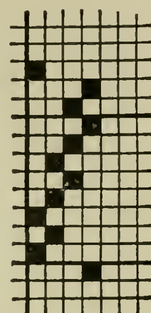


Fig. 44.

For instance, Fig. 37 is on 5 harnesses and could be indicated $\frac{1}{\quad 4}$ or 1 + 1 + 1 + 1 + 1, or 1, the move number, or $\frac{1}{\quad 4}$/1.

The weave on 4 harnesses, as shown at Fig. 43, is known as the 70-degree steep twill, the written formula is 1 + 0 + 0.

The terms 1 + 0 + 0, etc., refer to the position of the points in a base with reference to one another, counted horizontally in the example given. Thus, in Fig. 43 the mark on the first pick is placed in the first point or small square, that on the second pick moved in position 0, *i. e.*, in the same position; that on the third pick moved 0; that on the fourth moved 1, and so on throughout.

Fig. 44. weave commencing on 1st pick.
1 + 1 2d pick moves 1 forward.
1 + 1 — 1 3d pick moves 1 in opposite direction.
1 4th pick moves 1 forward.
1 + 1 5th pick moves 1 forward.
1 + 1 — 1 6th pick moves 1 in opposite direction, and so on until the weave begins to repeat. Similarly 3 + 3 — 5 may be commenced at any point as shown at Fig. 45; weave on 9 harnesses
+ 3 1st thread and 1st pick.
— 5 moves 5 in opposite direction.
+ 3 moves 3 forward.

Take Fig. 45 as an example. The weave is on 9 threads, therefore the counting or moving must be worked from 1 to 9.

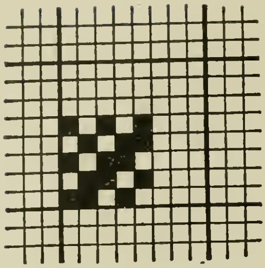


Fig. 41.

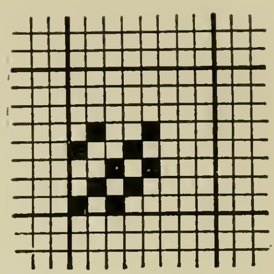


Fig. 42.

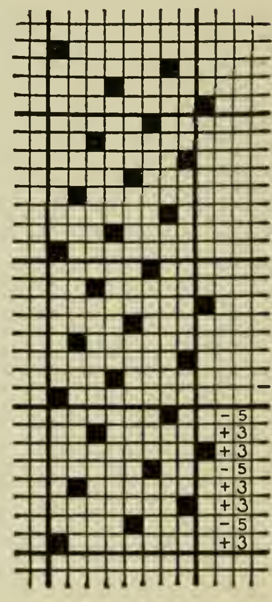


Fig. 45.

Commencing at the 1st thread, a point is placed on the 1st square, the 2d pick is marked—5 or 5 in the opposite direction, or, 9, 8, 7, 6, 5, hence the next point is on thread 5. The 3d pick is marked + 3 or 3 forward, or 6, 7, 8, the third point on the 8th thread; the 4th pick is marked + 3 or 3 forward, then 9, 1, 2, fourth point on 2d thread, 5th pick is marked — 5 or 5 in opposite direction, then, 1, 9, 8, 7, 6, fifth point on 6th thread, and so on throughout until the weave repeats.

The next step in the work is to produce as many designs as possible upon any given number of threads, and in doing so proceed systematically, as in the five-harness examples, first with 1 point, then with 2, and so on, until a complete series of simple lines, as in Figs. 37 to 42, has been run through, and, according to the number of threads, open out the space between the lines of twill. Make light and heavy lines, and vary them until there is no further room for variation, observing the repetitions of the pattern in the reverse order, both in the quantity of material which comes to the surface and in the position of the twill.

Diagrams for illustrating the construction of reclining and steep twills are shown in Fig. 46.

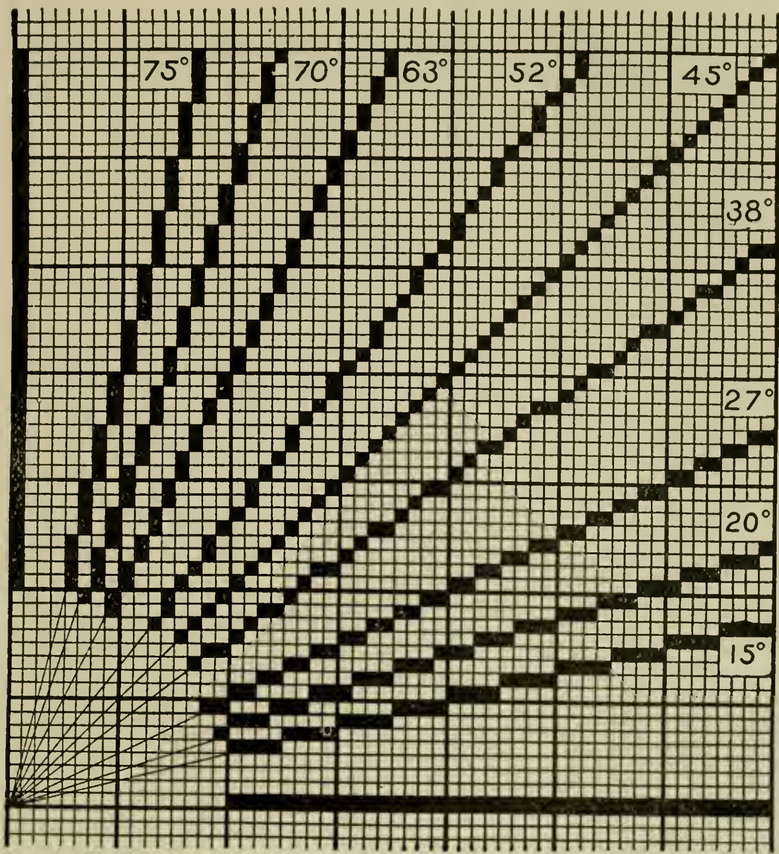


Fig. 46.

The	15°	reclining	twill	is	formed	by	moving	4	points,	Fig.	47
,,	20°	,,	,,	,,	,,	,,	,,	3	,,	,,	48
,,	27°	,,	,,	,,	,,	,,	,,	2	,,	,,	49
,,	35°	,,	,,	,,	,,	,,	,,	1+2	,,	,,	50
,,	45°	Regular	,,	,,	,,	,,	,,	1	,,	,,	51
,,	52°	Steep	,,	,,	,,	,,	,,	1+1+0	,,	,,	52
,,	63°	,,	,,	,,	,,	,,	,,	1+0	,,	,,	53
,,	70°	,,	,,	,,	,,	,,	,,	1+0+0	,,	,,	54
,,	75°	,,	,,	,,	,,	,,	,,	1+0+0+0		,,	55

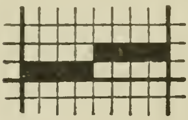


Fig. 47.

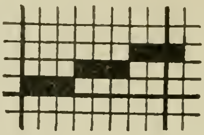


Fig. 48.

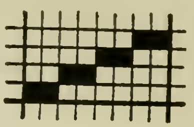


Fig. 49.

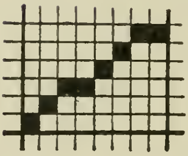


Fig. 50.

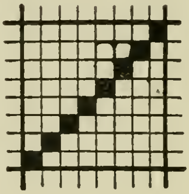


Fig. 51.

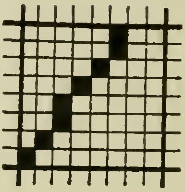


Fig. 52.

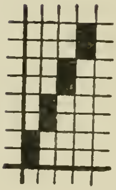


Fig. 53.

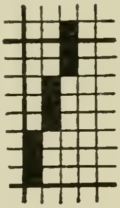


Fig. 54.

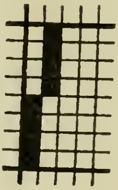


Fig. 55.

Any of the intermediate degree twills can be formed, according to the requirements of design.

PLAN OF TWILL MAKING.

Work out weaves from the following:—

(1) $\frac{1\;\;2}{2\;\;3}$ move 1	(13) $\frac{2\;\;2}{2\;\;3}$ move 1	(25) $\frac{3\;\;3}{3\;\;4}$ move 1
(2) $\frac{1\;\;2\;\;3}{1\;\;2\;\;3}$ move 1	(14) $\frac{2\;\;3\;\;4}{2\;\;3\;\;4}$ move 1	(26) $\frac{3\;\;4\;\;5}{3\;\;4\;\;5}$ move 1
(3) $\frac{1\;\;3}{2\;\;4}$ 45°	(15) $\frac{2\;\;4}{3\;\;5}$ 45°	(27) $\frac{3\;\;5}{4\;\;6}$ 45°
(4) $\frac{1\;\;1}{2\;\;3}$ 52°	(16) $\frac{2\;\;2}{2\;\;3}$ 52°	(28) $\frac{3\;\;3}{3\;\;4}$ 52°
(5) $\frac{2\;\;3}{2\;\;3}$ 63°	(17) $\frac{3\;\;4}{3\;\;4}$ 63°	(29) $\frac{4\;\;4}{4\;\;5}$ 63°
(6) $\frac{1\;\;2}{2\;\;3}$ 70°	(18) $\frac{2\;\;2}{3\;\;4}$ 70°	(30) $\frac{3\;\;4}{3\;\;4}$ 70°
(7) $\frac{2\;\;3}{3\;\;4}$ 45°	(19) $\frac{3\;\;3}{3\;\;4}$ 45°	(31) $\frac{4\;\;5}{4\;\;4}$ 45°
(8) $\frac{2\;\;2\;\;3}{2\;\;2\;\;2}$ 38°	(20) $\frac{3\;\;3}{4\;\;5}$ 38°	(32) $\frac{4\;\;4}{4\;\;5}$ 38°
(9) $\frac{4\;\;5}{4\;\;4}$ 27°	(21) $\frac{4\;\;5}{5\;\;6}$ 27°	(33) $\frac{5\;\;5}{4\;\;5}$ 27°
(10) $\frac{1\;\;1\;\;1}{1\;\;2\;\;2}$ 45°	(22) $\frac{2\;\;2\;\;2}{2\;\;3\;\;3}$ 45°	(34) $\frac{3\;\;3\;\;3}{3\;\;4\;\;4}$ 45°
(11) $\frac{1\;\;1\;\;1}{1\;\;2\;\;2}$ 52°	(23) $\frac{2\;\;2\;\;2}{2\;\;3\;\;3}$ 52°	(35) $\frac{3\;\;3\;\;3}{3\;\;4\;\;4}$ 52°
(12) $\frac{1\;\;1\;\;1}{1\;\;2\;\;2}$ 63°	(24) $\frac{2\;\;2\;\;2}{2\;\;3\;\;3}$ 63°	(36) $\frac{3\;\;3\;\;3}{3\;\;4\;\;4}$ 63°

FANCY DEGREE TWILLS.

1. Define the term "regular twill."
2. How many regular twills may be woven on five harnesses?
3. What is the move number for a 45° twill?
4. To what does the written formula refer?
5. Indicate two methods of expressing one complete repeat of the 1 up, 4 down twill.
6. Make a design for a 70° twill on four harnesses.
7. Make designs for the following:—Four harness + 1 + 1 — 1; nine harness + 3 — 5 + 3; five harness + 1 + 1 + 0.
8. Make a diagram illustrating 15°, 20°, 27°, 38°, 45°, 52°, 63°, 70°, and 75° twills.
9. Give move numbers for the degree twills given in question 8.

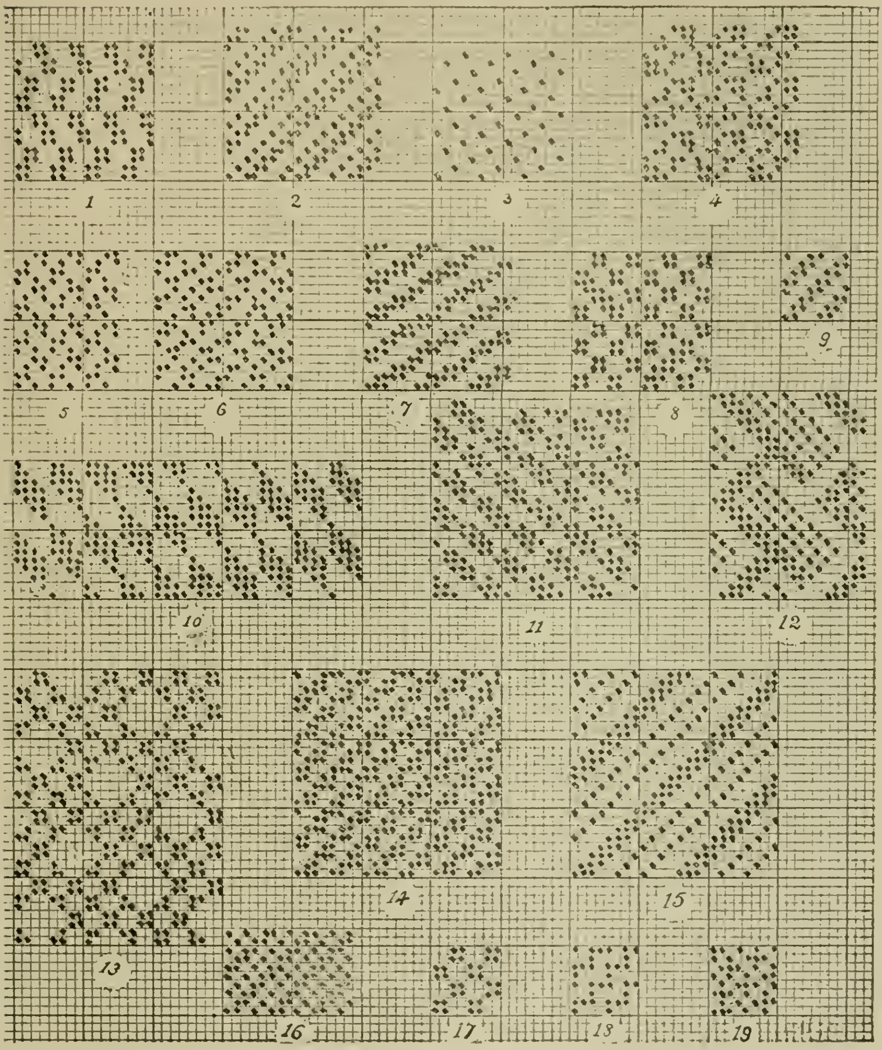
CUT WEAVES.

Combining weaves is an important branch of designing. Cut weaves which are formed by a combination of twills, sateens, or of both twills and sateens, are used extensively in the production of trouserings, suitings, dress goods, damasks and Jacquard effects.

The cut is formed in three different ways:—first, a complete break or cut-off should be made when reversing the position of a weave or at the point where two weaves are joined, if possible. The excessive floating of threads may thus be avoided. Second, when a sufficient break or cut-off cannot be made without causing two much of a float, another method of weaving for one, two, or three threads should be introduced between the weaves to form the cut-off. Third, avoiding the combination of weaves of too great a difference in the textures to be used in the same designs, as this will cause the fabric to weave either too loose or too tight according to the weaves, creating dissatisfaction in the weaving and selling of the fabric and greatly impairing its wearing qualities.

In explanation, Figure 56 is an example of a cut weave, the cassimere twill being combined with a basket to give a stripe effect. The design is twelve threads cassimere twill, four threads basket, twelve threads cassimere (left twill), four threads basket, or a total of thirty-two threads. With a solid filling, the basket effect would be preserved in both stripes. If, however, the filling is run two and two of different colors, the basket effect would be broken in one of the stripes. By referring to Figure 56, it will be seen that the first basket will weave as desired, but the second basket will be broken and appear as if woven pick and pick. In this case the combination must be changed so that the basket in both parts of the design will weave alike. Figure 57 shows one method of overcoming this defect, but the result is that the cut is not perfect in the first basket stripe. An overshot effect is given which spoils the basket. To weave this design on thirty-two threads, change the position of the first basket weave and the thread on either side of the basket, giving the design in Figure 58. A design for a stripe, six harness twill, and basket weave is given in Figure 59. These figures show that when designing stripes from a combination of twill and basket, an odd number of threads of twill should be used, generally one in excess of the

Complete the Weaves on the Accompanying Portions.



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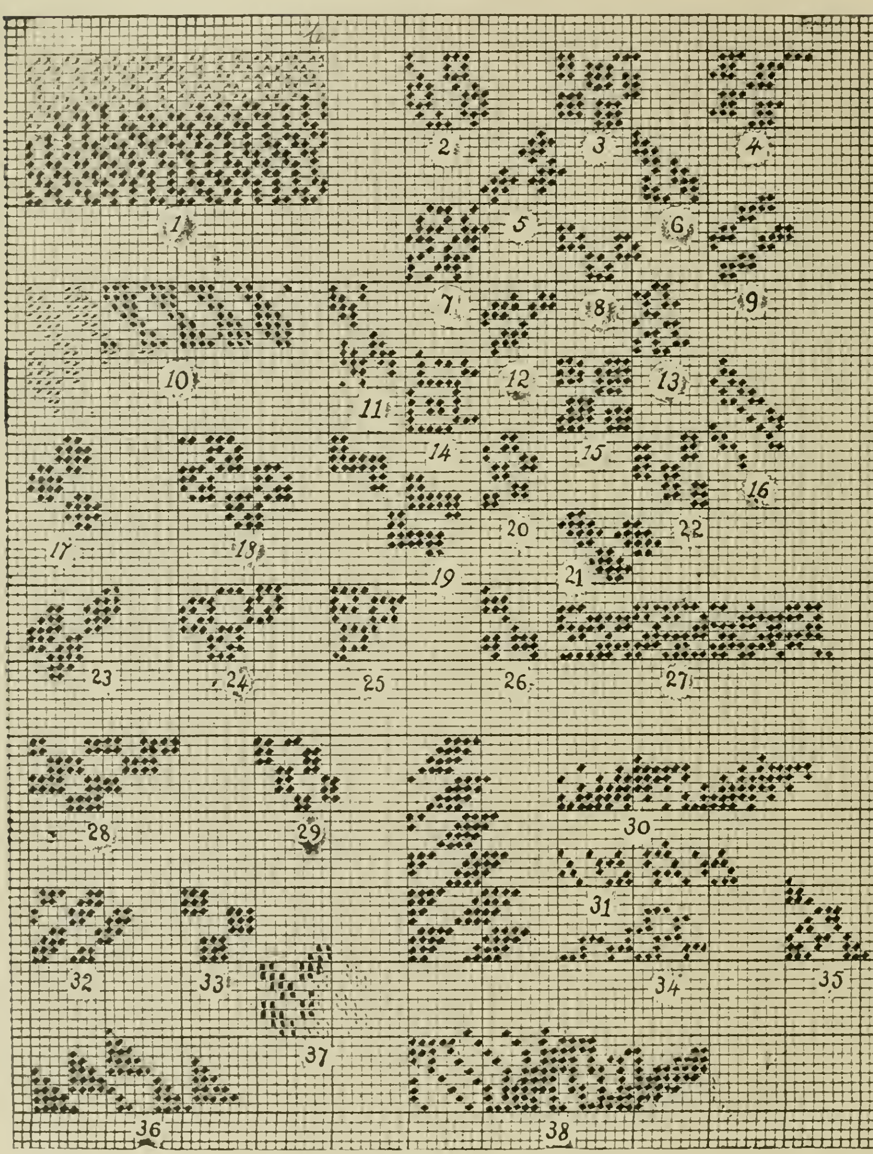
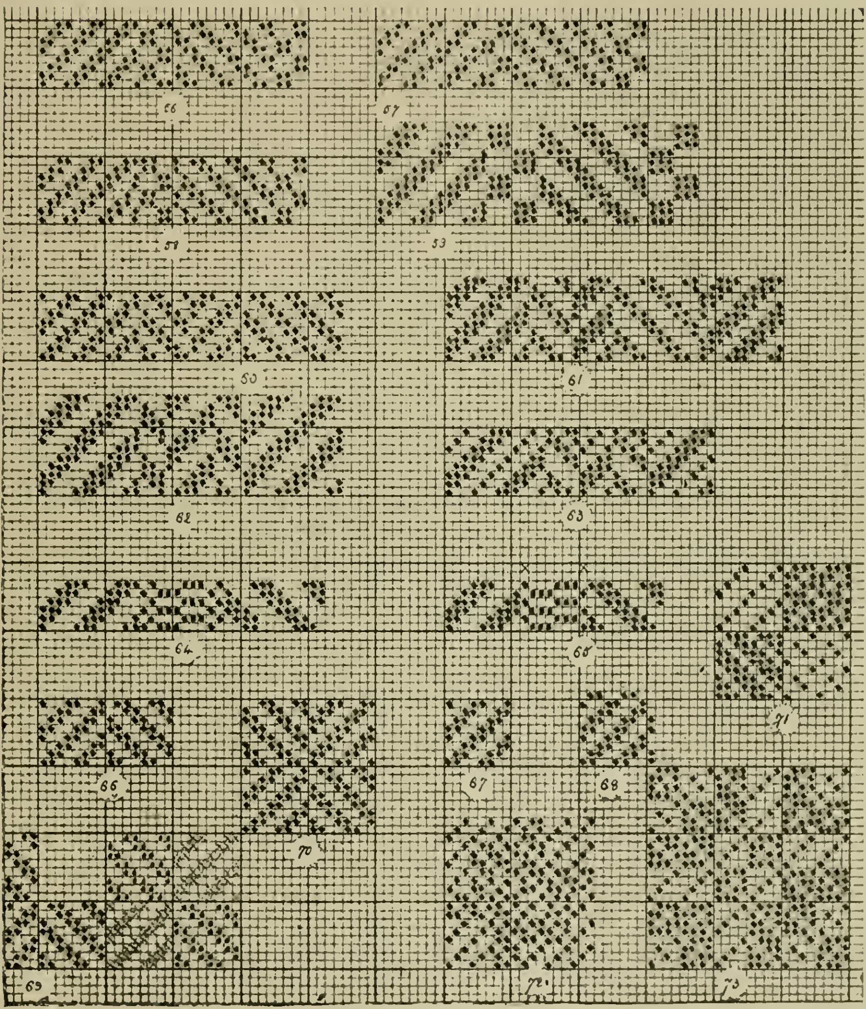


Complete the Weaves on the Accompanying Portions.



number of threads in one repeat in order that the basket weaves should come in the same relative positions. This is not necessary, however, when a solid filling is used or when the filling produces a hit-or-miss effect.

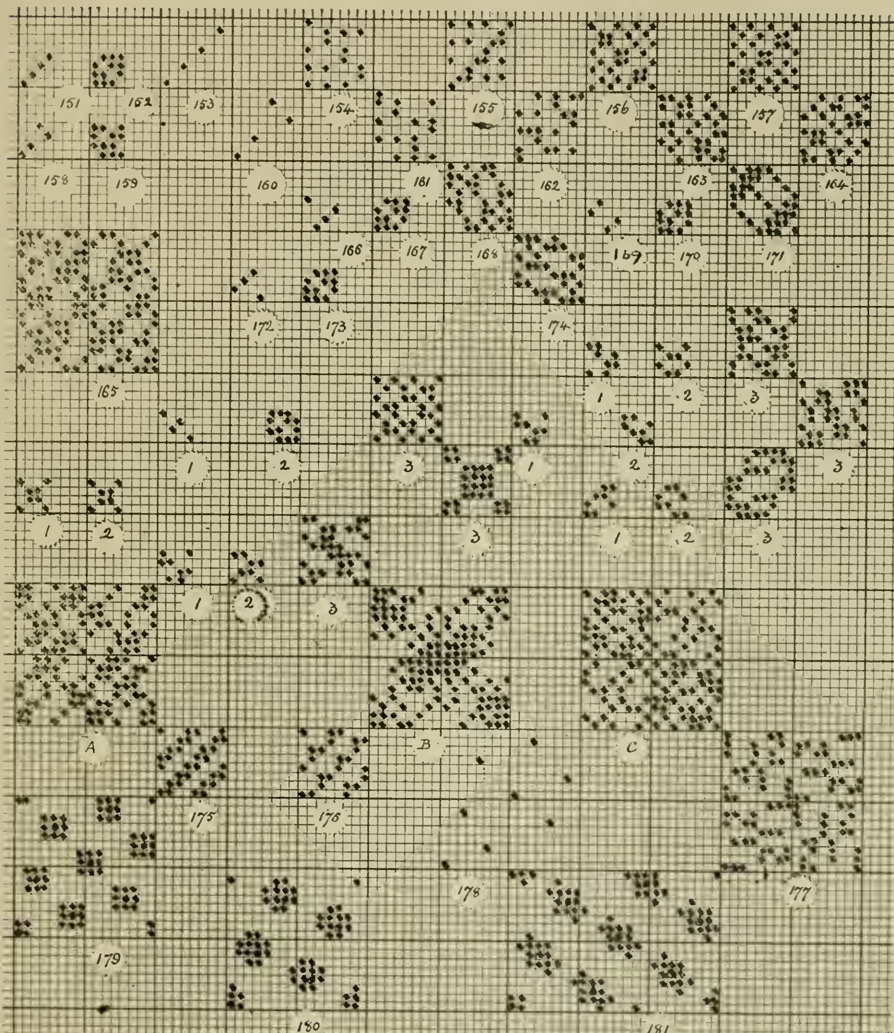
Herringbone effects are produced by using a warp flush twill for a desired number of threads, forming the cut or break, and using the same twill, filling flush for any desired number of threads. The effects produced in herringbone stripes are unlimited in number. Figure 60 shows a simple herringbone formed from the cassimere twill, twelve threads right twill, six threads left twill, six threads right twill, twelve threads left twill. A five harness herringbone is given in Figure 61; a six harness in Figure 62, and an eight harness in Figure 63. When reversing regular twills repeating on an even number of harnesses, the break should be made either at the completion of, or in the middle of the weave. This is shown in Figures 61, 62, and 63.

The combination of twills and ribs require the use of a thread weaving plain and the reverse of the rib or cord. This is shown in Figures 64 and 65. Frequently two threads of plain are used to make the cut more prominent.

Cut diamond effects are formed by a method similar to herringbones, the same principles being used in the extension of the design in the direction of the filling as those used in the direction of the warp. Figure 66 is a design for a herringbone stripe cassimere twill, eight threads right twill, eight threads left twill carried out for eight picks. To produce a cut diamond effect, form a cut with the ninth pick for sixteen threads and reverse the twill as in a herringbone stripe. Another method of forming the same design is to use the cassimere twill for one quarter of the design, Figure 67, form the cut on the last thread and pick, Figure 68 reverse, the twill and continue to the extent of the design, giving the result in Figure 69. The cuts are again made and the twill reversed for the remaining quarter of the design. The complete design is given in Figure 70.

Checkerboard or block effects may be woven either from twill weaves or from a combination of twills and broken weaves such as crowfoot or sateens The effect desired is of alternate squares of varying colors similar to a checkerboard. As a solid warp and a solid filling is generally used, the different effects must be produced by the weaves. Figure 71 illustrates a checker-

Complete the Weaves on the Accompanying Portions.



board effect woven from the swansdown, and crow twills and crowfoot warp and filling flush weaves. The method of constructing this design is similar to a cut diamond. The crow twill is used for that part of the design first requiring a warp effect; the cuts are formed and the swansdown and crowfoot weaves used for the filling effect in the cloth. The cuts are made and the balance of the design filled in with the crowfoot warp flush weave. A design using twills is given in Figure 72, and a fancy effect with twills and broken weaves in Figure 73.

CUT WEAVES.

1. How are cut weaves formed?

2. Give the different methods of forming a cut.

3. How may the excessive floating of threads be avoided?

4. Make a design as follows: 12 threads cassimere twill, 4 threads basket, 12 threads cassimere twill left twill, 4 threads basket forming a cut at the joining of the several weaves.

5. If the filling in the design in question 4 is picked two black, two red, would the basket effect be preserved in both basket stripes?

6. If the design in question 5 is defective, how could the defect be remedied?

7. What is the general rule for the number of threads to be used in the several stripes of a design for alternate stripes of twill and basket.

8. How are herringbone effects produced?

9. Make a design for the herringbone stripe using the 2 up, 1 down, 1 up, 2 down six harness twill.

10. Make a design for a stripe combining an eight harness twill and rib.

11. How are cut diamond effects formed?

12. Give the method in full of making a cut diamond from the 3 up, 3 down twill, illustrating each step.

13. What are checkerboard effects?

14. Make a design for a checkerboard effect using four different weaves.

15. Make a design for a fancy effect from the prunella and doeskin weaves.

16. Make a design for a fancy effect using twills and broken weaves.

DESIGN FROM A WRITTEN FORMULA.

Suppose a design is required similar to Fig. 74. The first question is: How many threads and picks are necessary to form the full design? Second: How many threads and picks are necessary for the large body square at the lower left-hand corner? Third: How many threads and picks are necessary for the small border squares? Fourth: What weave will be the most suitable for the required fabric?

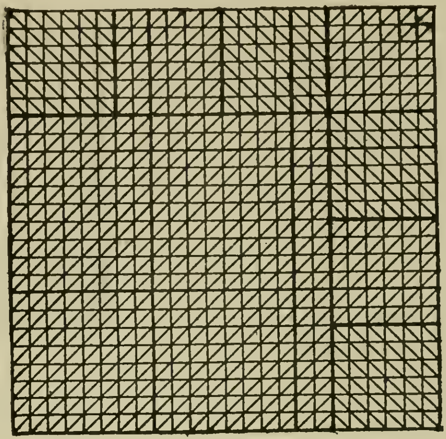


Fig. 74.

A design should never be made without taking into consideration the requirements of each operation and the effect to be produced. In the main body in the square of Fig. 74 the twill is running at an angle of 45°, and in the small squares the twill is running to the right and left in alternate squares. The first design is on 24 threads x 24 picks in one repeat of the design.

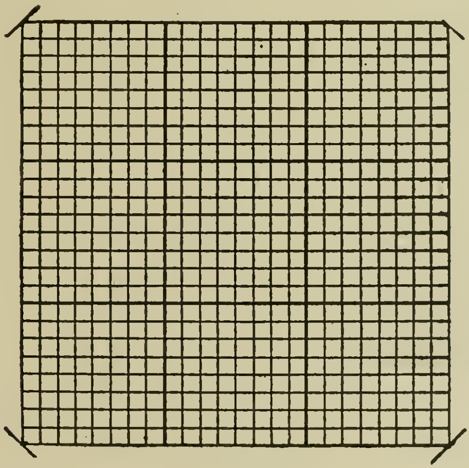


Fig. 75.

First. Mark off design paper to the required dimensions, Fig. 75.

Second. How many threads and picks are necessary for the large body square A at the left-hand lower corner? In this instance 18 x 18 are required. Mark off the design paper to the required number of threads and picks (see Fig. 76).

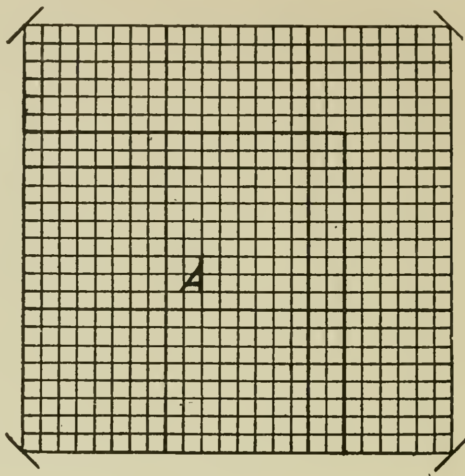


Fig. 76.

Third. How many threads and picks are necessary for the small border squares B and C? The border is divided into four parts of 6 threads x 6 picks each way (see Fig. 77).

Fourth. On examination of the skeleton design of Fig. 77 it can be divided into four sections, 1, 2, 3, 4, as shown in Fig. 78.

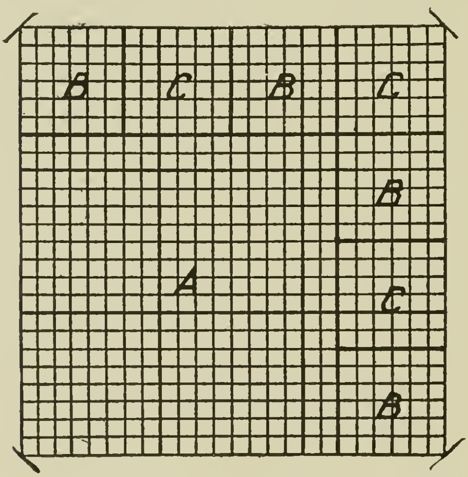


Fig. 77.

Fifth. Decide what weaves will be most suitable for the required fabric. This design, Fig. 74, shows a fine twill or diagonal, therefore the 3-harness twill, filling flush $\frac{1}{2}$ to right, which we will class weave "B1," and the 3-harness twill, warp flush $\frac{2}{1}$ to left, which we will call class weave "B2," must be used.

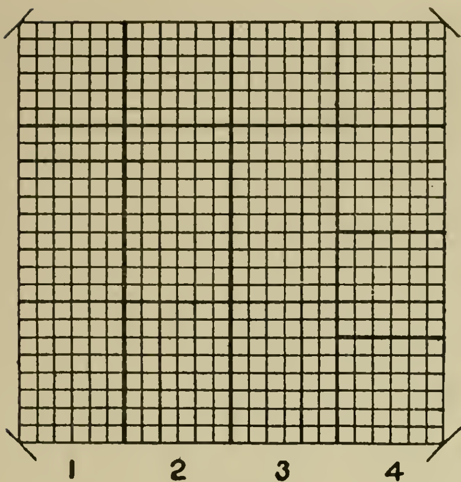


Fig. 78.

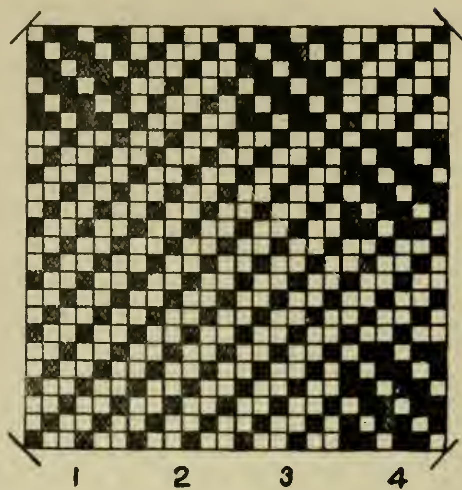


Fig. 79.

To construct the design from a written formula or problem.

PROBLEM. **Dress Goods Design (Fig. 79).**

24 threads and 24 picks.

Section 1.	6 threads	× 18 picks	B1.	See first section Fig. 78, 79
	6 ,,	6 ,,	B2.	
	—	—		
		24		
Section 2.	6 ,,	24 ,,	B1.	,, second ,, ,, ,, ,,
	—	—		
Section 3.	6 ,,	18 ,,	B1.	,, third ,, ,, ,, ,,
	6 ,,	6 ,,	B2.	
	—	—		
		24		
Section 4.	6 ,,	6 ,,	B2.	,, fourth ,, ,, ,, ,,
	6 ,,	6 ,,	B1.	
	6 ,,	6 ,,	B2.	
	6 ,,	6 ,,	B1.	
		—		
		24		

DESIGN FROM A WRITTEN FORMULA.

1. Give an outline of the process of laying out a design from a written formula.
2. How is the skeleton design divided?
3. What determines the weaves most suitable for the required fabric?
4. Construct a design (24 x 24) giving a check effect.
5. Write the formula for the design in question 4.

DRAFTING AND REDUCTION.

How to Obtain the Fewest Number of Working Harnesses.

This is an important section pertaining to designing, and necessary for the production of extended patterns on a limited number of harnesses.

Though presenting no hard line of study to those wishing to understand the operation, it is surprising that so much ignorance exists in reference to it, even by those conversant with the art of weaving in other respects. Briefly stated, drafting takes cognizance of two or more threads in the design for the pattern, which are found to be always working alike, that is, always up and always down together throughout the weaving operation, and unites them to one motion or harness, instead of employing separate harnesses for each individual thread. By this means a great variety of effects may be obtained, and large patterns produced in looms having the simplest appliances. Especially is this the case in the weaving of stripes, in looms capable only of allowing a limited number of harnesses, and with only one shuttle. But for the production of checks and stripes requiring a large number of picks and threads before the pattern repeats, the Dobbyhead, or an equivalent motion, is necessary to gain it. For this reason, although a design may be drafted so as to employ but few harnesses, yet the number of picks cannot be reduced, but must be fully carried out to the extent of the design.

Having reduced the design to the lowest number of requisite harnesses, the working plan or chain is found by taking the consecutive numbers from No. 1 to the highest figure shown beneath the design and placing them side by side in their order, according to the requirements of the design, so that they shall read 1, 2, 3, 4, 5, 6, 7, 8, and so on.

This will be seen on reference to Fig. 80, which is given to show the principle of drafting and reduction in its simplest form, which, however, is the same applied to all the more elaborate patterns. The numbers beneath the design are used for the purpose of obtaining those threads that are working alike, and also to obtain the nature and extent of the draft.

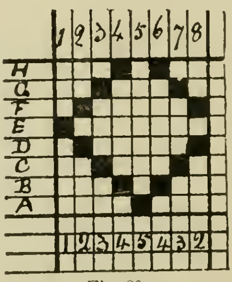


Fig. 80.

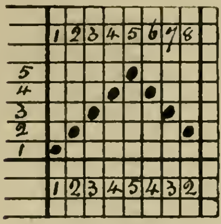


Fig. 81.

Fig. 81 shows the drafting or the threads drawn through the harnesses, as taken from the design, and the numbers beneath correspond with those found under the design. The horizontal lines represent the harnesses and the vertical lines represent the threads.

EXPLANATION.— Take Fig. 80, which represents a diamond pattern. The design stands upon 8 threads. See numbers on top. Begin at the bottom, at the left-hand corner, and note the filled spaces of each thread, which means their manner of working from the bottom to the top. When two or more threads are marked exactly alike, the same number at the bottom represents all of that kind. Thus the 1st thread is marked No. 1, and, of course, will require one harness to work it; the 2d thread is working different to the 1st, and will require another harness, marked No. 2; the 3d, 4th, and 5th threads are again different to any of the others, and so will require each different harnesses, and marked Nos. 3, 4, and 5. The 6th thread is marked 4 because it is working like the preceding thread marked 4, the 7th thread is marked 3 because it is like the preceding thread marked 3; and the 8th thread is marked 2 for the same reason that it is working like the thread marked 2. The numbers under the design now read 1, 2, 3, 4, 5, 4, 3, 2; therefore the highest number is five, which means that the design requires five harnesses to weave it. Whatever the highest number may be it represents the number of harnesses required. In this example five are required, and five parallel lines are drawn for the harnesses accordingly, and marked up the side 1, 2, 3, 4, 5. Now proceed to draw vertical lines to represent the threads drawn through the harnesses indicated by the numbers under the design, and just in the order in which they stand. No. 1 is drawn upon the first harness, No. 2 upon the second, No. 3 upon the third, No. 4 upon the fourth, No. 5 upon the fifth, No. 6 again upon the fourth, No. 7 upon the third, and No. 8 upon the second. See Fig. 81.

Having finished the draft, the next proceeding is to obtain the working plan or chain, which is a reduction of the design, so far as the threads are concerned. In this case the consecutive numbers from 1 to 5 are found together, so that all that is required is to copy exactly the first five threads of the design as they stand, which is shown at Fig. 82.

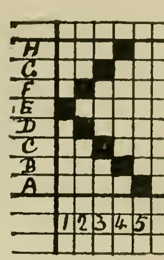


Fig. 82.

The next examples are of a more extended and practical character, containing mixed weaves. For the purpose of gaining the working plan from them, use the consecutive numbers from No. 1 to the highest. These are not found to be all together, as in Fig. 80.

Fig. 83 stands upon 24 threads and 4 picks, and consists of three different weaves, each weave being twice repeated, so that the first 4 numbers under each different weave must be taken for the working plan or chain, which gives the numbers consecutively as 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.

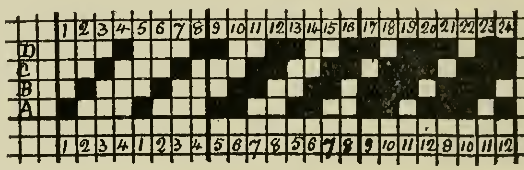


Fig. 83.

Reference to Fig. 83 will explain this. Drawing-in draft at Fig. 84. This design requires twelve harnesses and four picks to weave it. See Fig. 85.

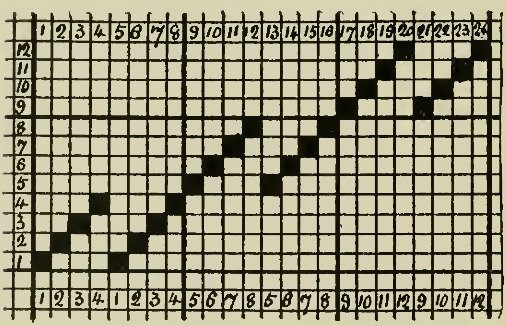


Fig. 84.

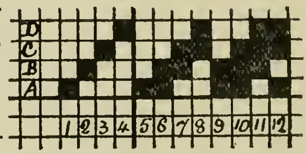


Fig. 85.

There is another consideration in reference to drafting which it is necessary to understand, and that is, it frequently happens that the full design is not given, only the draft and working plan, so that the figure intended to be produced by them is not always intelligible. Many designers adopt this method for the purpose of economizing time, and in practical

work in the mill this method is to be recommended, not simply for concealment, but it is all that is necessary for the use of the pattern weaver, chain builder, or loom fixer, to enable him to put the work into operation.

In order to obtain the full design from the reduced working plan and drawing-in draft, which is but the reverse method of that adopted in the previous examples, follow the draft and chain in the same manner as done with the design when making a reduction. Likewise number the threads on the harnesses consecutively at the top of the drawing-in draft, so that the place for each particular thread in the extended design will be indicated. A simple illustration will explain this.

Fig. 86.

In this figure six harnesses are required, on which are drawn twelve threads to complete the pattern. See Fig. 86. The working plan accordingly contains six threads. In another method sometimes adopted the working chain of the design is given, as in Fig. 86, but the draft is given in figures, and not on parallel lines. As, for instance, in the draft for Fig. 87 the numbers read 1, 2, 3, 4, 5, 6, 3, 2. 1, 6, 5, 4. All that is required is to draw as many horizontal lines as are represented by the highest number, which in this case is 6, number the lines consecutively, and proceed to draw the vertical lines upon them, according to the numbering of the threads, which would give the draft as at Fig. 87.

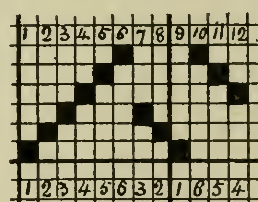


Fig. 87.

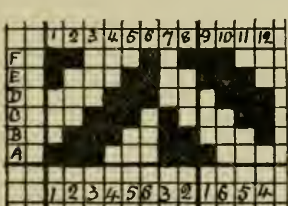


Fig. 88.

Full and extended design at Fig. 88.

Examples: — Reduce Figs. 89, 90, and 91 to the fewest possible number of harnesses.

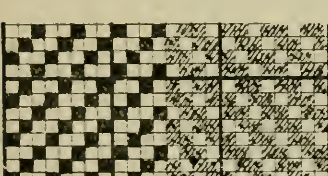


Fig. 89.

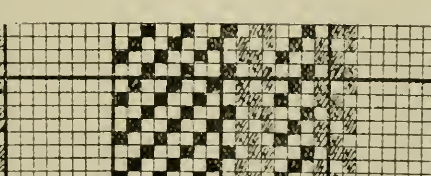


Fig. 90.

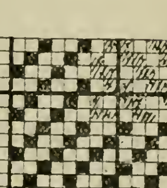


Fig. 91.

BROKEN DRAFTS.

Broken drafts are made from regular drafts by taking threads from the regular draft in some irregular order and so arranging them as to form a new draft which will give a weave of broken appearance when used with the regular chain. Different systems may be adopted in making these broken drafts, and they are often made from regular twill or sateen drafts.

Such a draft may be made from a twill draft by taking from the twill a number of threads and then omitting a number, in this way carrying out the draft to a repeat. These drafts are used to produce what are known as broken or skip twill weaves.

Another system of making broken drafts is by taking consecutive groups of threads from a sateen draft and rearranging them in alternate order, one group is drawn in the regular draft, the other group with the order of drawing reversed. Any number of threads desired may be used in a group, such as alternate 2's, alternate 3's, or 2's and 3's, etc. The length of the repeat is ascertained by obtaining the least common multiple of the number of harnesses and the number of threads contained in the sum of the two groups.

A third method of constructing a broken draft is by taking any number of harnesses which it is desired to use and selecting some uneven number, preferably greater.

DRAFTING AND REDUCTION.

1. Why is drafting necessary?

2. Define the word "drafting."

3. How does drafting affect the weaving of a design regarding the number of harnesses?

4. Describe the effect of drafting when weaving stripes with a large or small number of picks and threads.

5. Does drafting reduce the number of picks in a design?

6. What is the working plan or chain?

7. Describe the method of finding the chain for a design?

8. When drafting, what do the numbers below a design denote?

9. Illustrate drafting by using eight threads of the shalloon twill giving chain and draft for the complete design.

10. What do the horizontal and vertical lines in a draft represent?

11. Make the following design:

8 threads. 8 picks swansdown twill.
4 threads, 8 picks crow weave.
12 threads, 8 picks swansdown twill,
8 threads, 8 picks crow weave,
8 threads, 8 picks swansdown twill.

The design repeats on 40 threads and 8 picks, a cut being formed by the several weaves.

12. Make chain and draft for the design in question 11, explaining process in detail.

13. Describe the process of making a design from a chain and draft.

14. The chain for a design is as follows:

4 threads, 4 picks swansdown twill,
4 threads, 4 picks cassimere twill,
4 threads, 4 picks crow weave.

The draft reads: 1. 2, 3, 4, 1, 2, 3, 4, 5, 6, 7, 8, 5, 6, 7, 8, 9, 10, 11, 12, 9, 10, 11, 12.

Make a full design describing the method fully.

15. What is the advantage, to designers, in using chains and drafts in place of full designs?

COLOR EFFECTS.

Influence of Color on Weaves, or the Application of Color to Fabrics.

Many of the great variety of patterns produced in all lines of fabrics are made on the same weave, the change in effect being obtained in the arrangement of colors in the warp and filling. To understand how this change is made, it is only necessary to bear in mind that where warp is raised that color will appear on the face of the fabric, and where not, the filling color will appear. These changes are called color effects, the simplest form in which it can be designed is the common hair line, where the pattern shows one thread of a light color and one of a dark color, running lengthwise of the fabric. It is made on the plain weave. By a careful study of the lessons and exercises the method will be learned quickly, so that any number of effects can be produced.

These color effects are made so that an idea can be obtained of how any arrangement of colors, on a certain weave, would appear in the fabric after weaving. In making these designs, the first thing is to decide the weave to be used; for ex-

ample, the plain or cotton weave, Fig. 92. Next indicate the weave on the design paper by a small dot or faint mark, Fig. 93, which will serve as a guide to show which thread must be raised. Then indicate at the top and right-hand side of the design the arrangement of colors, Fig. 93, which we will assume to be one thread black and one thread white in the warp, and one pick white and one pick black in the filling. After having indicated the weave and the arrangement of colors, the next operation is to mark where the warp is raised as indicated by a small dot, the mark to be of such a color as indicated by the color on the top of the design, Fig. 94. When this has been done, mark every filling pick as indicated on the squares by being left blank, which indicates the warp down, with such color as represented on right side of design, Fig. 95. This pattern in color is called "The Hair-line." The simplest change from this hair-line pattern is to produce the bar effect in the width of the piece. This effect is made on the same weave and arrangement of color in the warp, the only change being in the filling, which is one of black and one of white. The chief characteristic of such hair-lines and stripes is that each color must cover its own, that is, if black warp is down a black filling should cover it. These color effects are the most important in designs for ladies' and children's dress goods, in cotton, woolen, and silk fabrics. Constant practice in making them will be of great assistance to the student, and an excellent experience will be obtained in regard to the various effects, as by the use of several colors the same effect will be obtained as in the cloth.

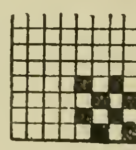


Fig. 92.
Plain Cloth, No. 1 A.

Explanation to Fig. 93.—The design is 8 threads by 8 picks, plain weave, or 8 threads and 8 picks of No. 1 A. The small dots indicate which threads must be on the surface, the marks on the top indicate the color of such threads in the warp which must appear on the surface of the fabric. In this example the warp is dressed 1 black and 1 white all the way across. The marks on the right side of Fig. 93 indicate the color of the weft or filling which must appear on the surface of the fabric.

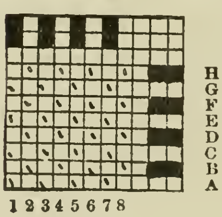


Fig. 93.

Explanation—Fig. 94 is like Fig. 93, with the warp threads lifted, showing the colors which are on the surface. In Fig. 93 the first thread and pick A is represented by $\boxed{\cdot}$ which indicates such thread to be lifted, and in Fig. 94 the same square is filled in black, which is the color on the surface of the fabric, the 2d thread and 1st pick is represented by $\boxed{\ }$, which indicates such thread to be down, and would be covered by the weft, the surface of the cloth at this point being the color of the weft. The 2d pick B, 1st thread is represented as down $\boxed{\ }$, this would be covered by the filling, the 2d thread, pick B, is represented by $\boxed{\cdot}$, which indicates the thread to be on the surface. Refer to the color mark over the second thread in Figs. 93 and 94; in this case it is white, therefore, white will be on the surface of the cloth.

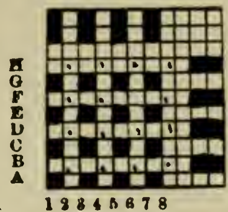


Fig. 94.

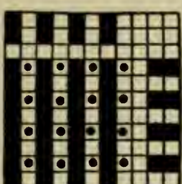


Fig. 95.

Explanation to Fig. 95—This is like Fig. 94 interwoven with the filling as shown at the right hand side. Detail: 1st pick A, white, under black and over white alternately.

2d pick B, black, over black and under white alternately.

3d pick like the first. 4th pick like the 2d, and so on, thus forming the "Hair-line pattern," one dark line and one light line down the cloth. In the hair-line design black covers black, white covers white.

Explanation to Fig. 96.—The particulars for the warp and weave are identical with Nos. 93, 94, and 95, but take particular notice how the weft or filling is interwoven:

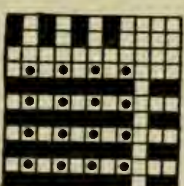


Fig. 96.

The pick A is black in the place of white. The pick B is white in the place of black, or, black covers white and white covers black, thus making the dark line across the fabric as shown in Fig. 96.

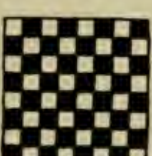


Fig. 97.

Explanation to Fig. 97. — This shows the effect of a plain weave, warp solid black, filling solid white.

Fig. 98 is an example of the plain weave on 8 threads and 8 picks, arranged in the following manner:

1st section 4 threads	4 threads and 4 picks, No. 1 A, 4 ,, ,, 4 ,, No. 1 A,	Commencing with the 2d thread.
2d section 4 threads	4 threads and 4 picks, No. 1 A, 4 ,, ,, 4 ,, No 1 A,	Commencing with the 2d thread

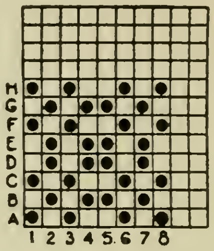


Fig. 98.

Explanation.—No. 1 A is the plain weave on 2 threads. 1 up, 1 down. Fig. 98 calls for a design of 8 threads by 8 picks, 4 threads and 4 picks, No. 1 A, which will read on the design paper: 1st section of 4 threads—

1st pick A, 4 threads, 1st up, 2d down, 3d up, 4th down.
2d ,, B, 4 ,, 1st down, 2d up, 3d down, 4th up.
3d ,, C, 4 ,, 1st up, 2d down, 3d up, 4th down.
4th ,, D, 4 ,, 1st down, 2d up, 3d down, 4th up.

This is the first part of 1st section, 4 threads and 4 picks. See the first 4 threads and picks 1 to 4 and A to D, Fig. 98.

Second part of 1st section reads, 4 threads and 4 picks, No. 1 A, commencing with the second thread, which will read on the design paper:

1st section of 4 threads	5th pick E, 4 threads, 1st down, 2d up, 3d down, 4th up. 6th ,, F, 4 ,, 1st up, 2d down, 3d up, 4th down. 7th ,, G, 4 ,, 1st down, 2d up, 3d down, 4th up. 8th ,, H, 4 ,, 1st up, 2d down, 3d up, 4th down.

See Fig. 98. Threads 1 to 4, and picks E, F, G, H.

This completes the 1st section, 4 threads and 8 picks.

Now take the 2d section of 4 threads, Nos. 5, 6, 7, 8, in Fig. 98.

First part of 2d section reads, 4 threads and 4 picks, No. 1 A, commencing with the 2d thread, which will read on the design paper:

Pick A, 5th thread down, 6th thread up, 7th thread down, 8th thread up.
,, B, 5th ,, up, 6th thread down, 7th thread up, 8th thread down.
,, C, 5th ,, down, 6th thread up, 7th thread down, 8th thread up.
,, D, 5th ,, up, 6th thread down, 7th thread up, 8th thread down.

Second part of section 2 reads, 4 threads and 4 picks, No. 1 A, which will read on the design paper:

Pick E, 5th thread up, 6th thread down, 7th thread up, 8th thread down.
,, F, 5th ,, down, 6th thread up, 7th thread down, 8th thread up.
,, G, 5th ,, up, 6th thread down, 7th thread up, 8th thread down.
,, H, 5th ,, down, 6th thread up, 7th thread down, 8th thread up.

Fig. 99 is the same weaving plan as given in Fig. 98.

The warp is dressed 1 black and 1 white.

The filling is interwoven 1 white and 1 black.

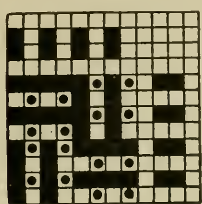


Fig. 99.

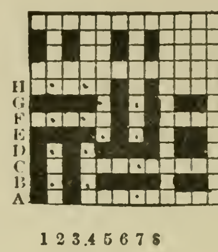


Fig. 100.

Fig. 100. The design is on 8 threads and 8 picks, composed of 4 threads and 8 picks, No. 1 A, 4 threads and 8 picks, No. 1 A, commencing with the 2d thread.

The warp is dressed 1 black, 1 white, 1 black, 2 white, 1 black, 1 white, 1 black=8 threads.

The filling is interwoven 1 white, 1 black, 1 white, 2 black, 1 white, 1 black, 1 white,=8 picks.

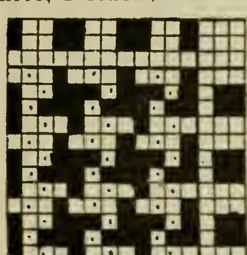


Fig. 101.

Fig, 101. This design is shown on 12 threads by 12 picks of No. 1 A.

The warp is dressed 1 black, 2 white, 2 black, 2 white, 2 black, 2 white, 1 black=12 threads.

The filling is interwoven 1 white, 2 black, 2 white, 2 black, 2 white, 2 black, 1 white=12 picks.

Example No. 1. On plain weave, 16 threads x 16 picks.

1 Red, 1 Black } 16 Threads. 1 Black, 1 Red } 16 Picks.

Example No. 2. On plain weave, 16 threads x 16 picks.

1 Red, 1 Black } 16 Threads. 1 Red, 1 Black } 16 Picks.

Example No. 3. On plain weave, 20 threads x 20 picks.

1 White 1 Black 2 White 1 Black	20 Threads.	1 Black 1 White 1 Black 2 White	20 Picks.

Example No. 4. On plain weave, 12 threads x 12 picks.

2 White 1 Black	12 Threads.	2 White 1 Black	12 Picks.

Example No. 5. On plain weave, 16 threads x 16 picks.

2 Black 2 Green	16 Threads.	2 Black 2 Green	16 Picks.

EXPLANATION TO EXAMPLE NO. 1.--On plain weave, 16 threads x 16 picks, means that 16 threads or squares each way on the design paper must be used, then over the threads mark 1 red, 1 black, repeating these for 16 threads, then mark on the side of the design the filling, 1 black, 1 red, for 16 picks, and proceed as explained in Fig. 90.

EXERCISES FOR PRACTICE.

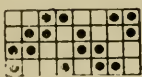
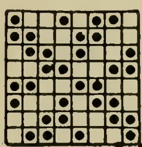
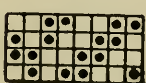
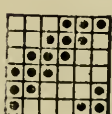
All on the Plain Weave.

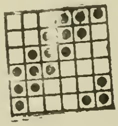
	WARP.		FILLING.	
1.	1 Red 1 Black	16 Threads.	1 Black 2 Red	16 Picks.
2.	1 Red 1 Black	16 Threads.	1 Red 1 Black	16 Picks.
3.	1 White 1 Black 2 White 1 Black	20 Threads.	1 Black 1 White 1 Black 2 White	20 Picks.
4.	2 White 1 Black	12 Threads.	2 White 1 Black	12 Picks.
5.	2 Black 2 Green	16 Threads.	2 Black 2 Green	16 Picks.

EXERCISES FOR PRACTICE.

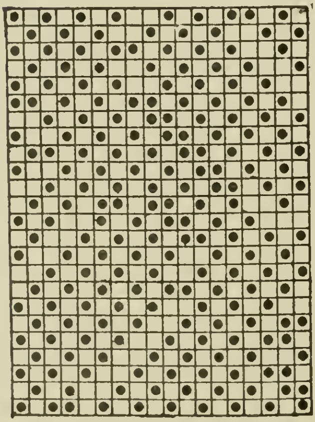
Sketch on point paper the effect produced by the following weaves and colorings:—

	WEAVE.	WARP.	FILLING.
(1)		Color— 1 Ground—1 } =2	as warp
(2)	same as (1)	Color— 2 Ground—2 } =4	as warp

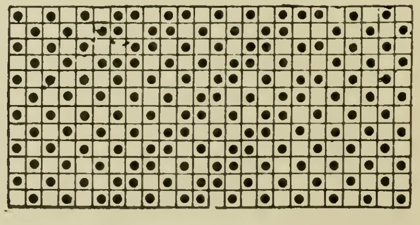
WEAVE.	WARP.	FILLING.
(3) same as (1)	Color— 2 Ground—2 } =4	as warp
(4) same as (1)	Color— 4 Ground—4 } =8	as warp
(5) same as (1)	Color— 2 2 Ground—1 3 } =8	Color— 1 3 Ground—4 . } =8
(6) 	Color— 4 Ground—4 } =8	as warp
(7) 	Color— 1 1 Ground—2 . } =4	as warp
(8) same as (6)	Color— 1 1 Ground—2 . } =4	Color— . 1 Ground—1 . } =2
(9) 	Ground—2 2 Color— 4 . } =8	Ground—3 1 Color— 4 . } =8
(10) 	Ground— 1 No. 1 Color—1 No. 2 Color—2 } =4	as warp
(11) same as (10)	Ground—1 1 Color— 2 . } =4	as warp
(12) same as (10)	Ground—3 Color— 3 } =6	Color— 3 Ground—3 } =6
(13) same as (10)	Ground—3 Color— 3 } =6	Ground—1 Color— 1 } =2
(14) same as (10)	Ground—. 1 Color— 2 . } =3	Ground—1 Color— 1 } =2
(15) same as (10)	Ground—. 1 Color— 2 . } =3	Ground—. 3 Color— 2 1 } =6
(16) same as (10)	Ground—1 1 3 2 Color— 1 1 3 . } =12	Ground—1 3 3 Color— 1 3 1 } =12
(17) same as (10)	Ground—. 1 3 Color— 1 1 . } =6	Ground—. 1 Color— 2 . } =3
(18) same as (10)	Ground—2 1 Color— 1 2 } =6	as warp
(19) 	No. 1 Color— 1 3 No. 2 Ground—1 1 } =16 4 times twice	No. 2 Ground—All

WEAVE.	WARP.	FILLING.
(20) same as (19)	No. 1 Color— 1 1 1 2 2 No. 2 ,, 1 1 1 2 2 No. 3 Ground—2 2 2 2 2 =24	No. 3 Ground—All
(21) same as (19)	No. 1 Color— 1 1 1 2 2 No. 2 ,, 1 1 1 2 2 No. 3 Ground—2 2 2 2 2 =24	No. 2 Color— 1 1 No. 3 Ground—2 . =4
(22) same as (19)	No 1 Color— 2 2 No. 2 Ground—1 3 =8	No. 1 Color— . 4 No. 2 Ground—1 3 =8
(23 	No. 1 Color— 1 2 . . 2 No. 2 ,, 1 . 1 1 . No. 3 Ground—1 1 2 2 1 =24 4 times	No 1 Color— 1 No. 3 Ground—2 =3
(24) same as (23)	No. 1 Color— 1 3 No. 2 Ground—1 3 =36 6 times 4 times	No. 1 Color— 2 No. 2 Ground—1 =3
(25) same as (23)	No. 1 Color— . 1 1 3 No. 2 Ground—1 1 3 2 =12	No.1 Color— .131 No.2 Ground-133. =12
(26) plain	Ground— 1 1 1 1 1 No. 1 Color 3 . 1 1 . =40 4 times 4 times	
(27) same as (26)	Ground— 1 1 1 No. 1 Color— 1 1 . =20 4 times 4 times	
(28) same as (26)	Ground— 1 1 1 No. 1 Color— 1 1 . =5	
(29) same as (26)	Ground— 1 1 1 1 1 No. 1 Color—2 . 1 2 . =24 3 times twice	

Sketch on point paper the effects produced by weaves 30 and 31 warped and picked 1 color
1 ground
2



30



31

COLOR EFFECTS.

1. Define the term "color effect."

2. Describe the "common hair line" giving the weave required, the scheme of warp, and system of filling.

3. Make a design for a common hair line (8 x 8), red and black to be complete in detail.

4. How are the risers in a design for a color effect filled in, or colored?

5. What governs the coloring of the risers in a color effect?

6. How are the sinkers, or blank spaces in a color effect colored, and upon what does the difference in color of the separate squares depend?

7. How may the line effect be changed to a bar without altering the weave?

8. What is the chief characteristic of hair line stripes?

9. In what classes of fabrics are color effects used?

10. Given, the plain weave (8 x 8). Scheme of warp and filling is one red, one black. Make a color effect for this design.

11. Given, the plain weave (8 x 8). Scheme of warp one red, one black, filling, one black, one red. Make a color effect for this design.

12. Describe fully the difference existing between the color effects produced in questions 10 and 11.

13. What benefit is derived from making color effects on design paper?

PLAIN AND IRREGULAR RIB WEAVES.

After the plain and twill weaves have been studied, the next class of weaves is the derivative weaves, or those which are designed by using one of the foregoing weaves as a basis.

The simplest class of these is the rib. This is formed from the plain or cotton weave as a foundation.

Fig. No. 102 is an enlarged diagram of a fabric woven on the simplest rib weave which can be constructed. It is made by raising one warp thread for two consecutive picks, and lowering the same warp thread under the next two picks, the second thread being exactly the reverse of the first.

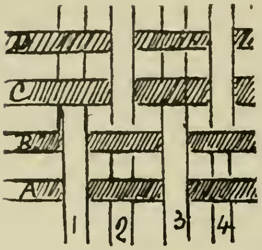


Fig. 102.

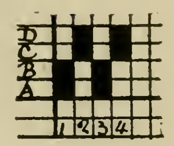


Fig. 103.

By a careful study of Fig. 102 and Fig. 103 a clear idea of the designing of these weaves will be obtained. The warp thread No. 1 is raised when the pick A is inserted and the same position of warp threads is obtained in the case of the second pick B.

When C and D are woven the warp thread No. 1 passes under them, the warp thread No. 2 passes under A and B and over C and D, which is the reverse of the intersections on thread Number 1.

It will be seen that this weave is nothing more than the plain weave with an additional pick in the direction of the filling. This causes the warp to cover the filling, and this effect is called a rib, made by the warp. These weaves are called warp-rib weaves, because the rib line runs across the piece or width of the fabric. The threads three and four are the duplicates of one and two. This weave repeats on two harnesses and four picks. Diagram 102 is the design for the enlarged section of the fabric.

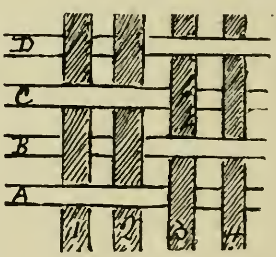


Fig. 104.

Warp-rib weaves do not have the extended use of the filling-rib weaves. These are also an enlargement of the basis plain weave, but instead of being in the direction of the filling, the rib is in the direction of the warp. Fig. 104 and Fig. 105 illustrate the simplest filling-rib weaves which can be constructed. Fig. 104 is the enlarged section of the fabric, and Fig. 105 is the design for Fig. 104.

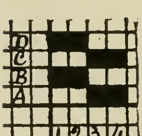


Fig. 105.

The pick A is over the two threads 1 and 2 and under the two threads 3 and 4; the second pick B is the reverse of A, and the third and fourth picks C and D are the duplicates of A and B. The weave repeats on four warp threads and two picks. In the fabrics woven on this principle the face rib is formed by the filling, covering the warp almost entirely. On account of this characteristic these weaves are used largely in the manufacture of woolen and cotton union fabrics, that is a cotton warp with

woolen filling; but on account of the slippery character of the cotton warp and the filling crossing each bunch or set of threads in the same manner, it is found that in the fabric the filling will slip or pull on the warp and form open spaces. This defect can be somewhat remedied by using such a weave as is shown in Fig. 106. In this weave it will be noticed a warp thread is lowered on every rib or cord. This additional intersection holds the filling and keeps it from slipping on the warp.

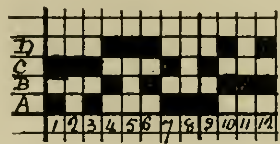


Fig. 106.

The fancy and irregular rib weaves are made from the plain rib weaves. These consist of the combination of two or more rib weaves of various widths in one design. Fig. 107 shows the design for a weave of this class, which repeats on three threads and two picks. Fig. 108 is the same idea designed for warp rib.

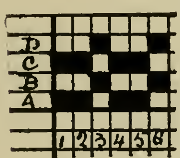


Fig. 107.

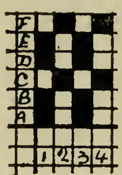


Fig. 108.

The student is advised to make the following weaves and enter them in a book:

Warp-Rib. Make out designs for warp-rib weaves to repeat on two harnesses and six picks, for two harnesses and eight picks, also for two harnesses and ten picks.

Filling-Rib. Make designs for filling-rib weaves to repeat on six threads and two picks; also eight threads and two picks; also ten threads and two picks.

Irregular and Fancy Rib. Make out designs for irregular rib weaves of this character, consisting of the combining of those weaves where the filling crosses two threads and three threads, three threads and one thread, four threads and two threads, and four threads and one thread.

Also make out designs where the warp thread crosses the same number of picks as the warp threads in the above examples.

Also a diagram of each weave and a cut section of the first and second picks of each design.

PLAIN AND IRREGULAR RIB WEAVES.

1. What are derivative weaves?
2. From what class of weaves are ribs derived?

3. Make a design of the simplest rib weave explaining the interlacing of the first two threads.

4. Compare this weave with the plain weave. Explain the differences existing between the two weaves.

5. What is a warp rib?

6. In which direction does the rib line run in a fabric woven from a warp rib weave?

7. Make a diagram for the design in question 3.

8. What are filling rib weaves?

9. Which are used more extensively, warp or filling ribs?

10. What is the effect produced in a fabric woven from a filling rib weave?

11. Make a design for the simplest filling rib weave.

12. Make a diagram for the design in question 11 and compare with the diagram in question 7. Explain the differences existing between the two diagrams in regard to interlacing of warp and interweaving of filling.

13. What class of goods are woven from filling rib weaves?

14. What defect is often found when these weaves are used for a fabric woven from a cotton warp and woolen filling?

15. How may this defect be overcome?

16. What are fancy and irregular rib weaves? Illustrate with a design.

FIGURED RIB WEAVES.

The figured weaves of this class are produced by combining the effects of the warp and filling rib weaves. In the filling effect weaves the rib lines run in the direction of the warp, and in the warp effects in the direction of the filling. The first step in making figured rib weaves is to break the rib line or to change it after a certain number of warp ends. The method of designing these weaves is shown in Fig. 109, where the rib line on the first six warp ends is the same, then by raising the intersection one pick the rib line is broken from a straight line across the fabric. This break also covers six ends, so that the weave

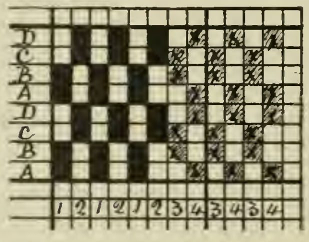


Fig. 109.

repeats on four picks and twelve warp ends. This weave can be varied considerably by using a different number of warp ends in the change of the rib line, such as using twelve ends for the first direction of rib line, and then a smaller number for the second direction.

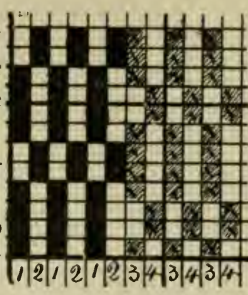


Fig. 110.

Fig. 110 is the combination of the four up and two down rib weave, using six ends for each change of the rib line; this makes a broad and a narrow rib line, and is a very good fancy effect. It repeats on twelve ends and six picks. By using various rib weaves and changing the arrangement of the number of threads used for the several widths, a great variety can be produced.

FILLING EFFECT FANCY RIB WEAVES.

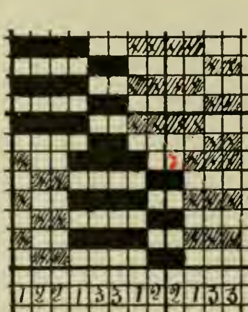


Fig. 111.

These weaves are designed on the same principle as the warp effect rib weaves, except that the rib line runs in the direction of the warp instead of the filling. Fig. 111 shows the narrow and wide rib weaves combined—the rib line running for six picks then changing on the next six. This will produce a wide and narrow rib effect alternating.

The filling effects, as in the warp effects, can be varied by using various widths of rib weaves and different numbers of picks for the various widths.

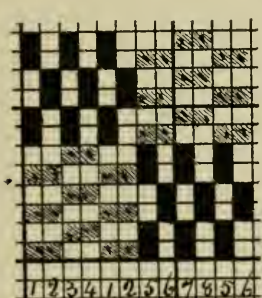


Fig. 112.

The next class of figured rib weaves is to combine the warp and filling effects in one weave. This is usually done in the shape of block effects, using the warp or filling effect for the ground and the opposite of what is used for the ground work of the pattern for the figure. Fig. 112 is the combination of the two up and two down, using the filling effect for six ends and six picks,

and the warp effect for six ends and six picks; this repeats on twelve ends and twelve picks.

In Fig. 113 is an idea for a weave of this character, each square representing eight ends and eight picks. Where W is marked use warp face, and in those marked F filling face rib weave. Make out this weave, which will require thirty-two ends and thirty-two picks; also make two other designs of this same class. Make designs for three of the figured warp effect rib and three of the figured filling effect, marking number of ends used for each weave.

8	F.	F.	W.	F.
8	F.	F.	F.	W.
8	F.	W.	F.	F.
8	W.	F.	F.	F.
	8.	8.	8.	8.

Fig. 113.

FIGURED RIB WEAVES.

1. What weaves are used as foundations for figured rib weaves?

2. In what direction do the rib lines run in filling effect rib weaves?

   In warp effect rib weaves?

3. What is the first step in making figured rib weaves? Explain fully how this is accomplished.

4. How may figured rib weaves be varied in effect when the same foundation weaves are used?

5. How is a fancy effect giving a broad and narrow rib line designed?

6. Name two methods of producing figured rib weaves.

FILLING EFFECT FANCY RIB WEAVES.

7. How are filling effect rib weaves designed?

8. Make a design for a fancy filling rib effect combining narrow and broad lines alternately.

9. How may the effects of filling rib weaves be varied?

10. How are block effects produced from rib weaves?

11. Describe fully each step used in the designing of block effects, illustrating same on design paper.

OBLIQUE RIB WEAVES.

Oblique rib weaves are a combination of warp and filling effect rib weaves, and are principally used in the manufacture of

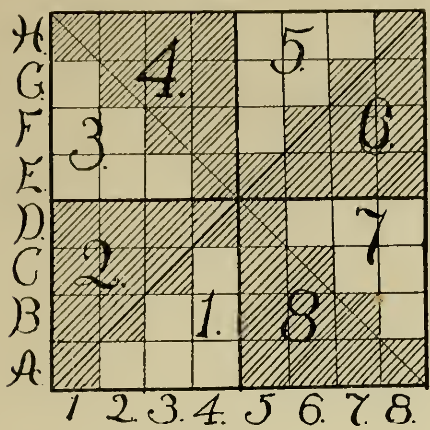


Fig. 114.

what are called bird's eye effects. They produce a square pattern in the cloth, which fact will be readily observed from a careful study of the weaves.

To design these weaves, first mark off on the squared paper the repeat of the weave; that is, if it is required to be woven as eight harness, mark a square containing eight ends and eight picks; subdivide this square into eight parts, as shown in Fig. 114, and number each triangle in rotation 1, 2, 3, 4, 5, 6, 7, 8. Mark in each uneven numbered square the warp effect rib weave (see Fig. 115) and in each even numbered square the filling effect rib weave, which produces the completed oblique rib weave, Fig. 116.

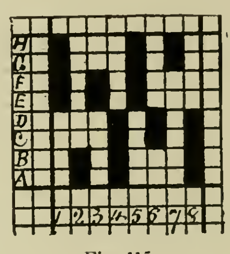


Fig. 115.

This procedure can be reversed, that is, the filling effect rib can be designed in the uneven numbered triangles and the warp effect rib in the even numbered triangles, which will produce the finished weave, Fig. 117.

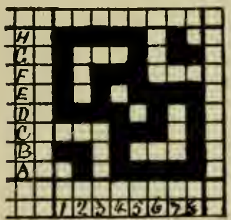


Fig. 116.

All weaves of this class are designed either commencing rib effects alternating with filling or the reverse.

Make designs for 6, 8, 10, 12, 14, 16 harness weaves of this class, using warp effect rib in first triangle, also make 6, 8, 10, 12, 14, 16 harness weaves, using filling effect rib in first triangle.

These weaves are also combined with plain rib weaves for producing checks, usually using the oblique rib weave as the groundwork of the check and the plain rib weave as the overplaid or check. A weave of this class is shown in Fig. 118, where the groundwork of check is the eight-

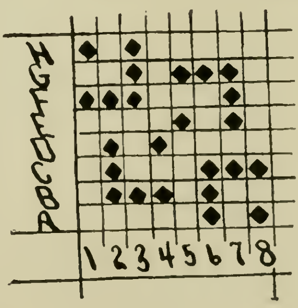


Fig 117.

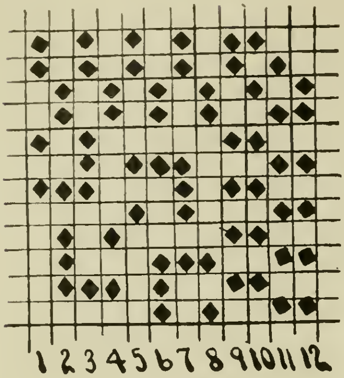


Fig. 118.

harness oblique rib weave, designed by commencing with the filling effect rib in first triangle and the four-harness rib filling effect for the warp over-checking, and warp effect for filling over-checking.

These combination weaves are simple, the only difficulty being experienced where the warp and filling effects of over-checking join, and at this point care should be taken that the weaves come together, preserving as near as possible the effect of both.

Design two weaves of this class, combining the ten and twelve-harness oblique weave with warp and filling effect rib weave.

These weaves are principally used in the manufacture of piece-dyed worsteds.

OBLIQUE RIB WEAVES.

1. What weaves are combined to produce oblique rib weaves?
2. What are oblique rib weaves chiefly used for in the manufacture of textiles?
3. What is the effect produced in a fabric by oblique rib weaves?
4. Give a brief description of the method used for designing oblique rib weaves.
5. How may the effect obtained in question 4 be changed so as to produce the reverse rib effect?
6. How are all weaves of this class designed?
7. How are check effects produced by oblique rib weaves?
8. What difficulty is experienced when designing check effects from this class of weaves?
9. How may this defect be overcome?

BASKET WEAVES.

The common weaves of this class are simply an enlargement of the plain or cotton weaves, in that the intersections are one end

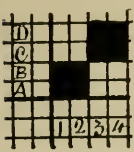


Fig. 119.

up and one end down and one pick up and one pick down. To enlarge on this requires that the number of ends and picks on the same intersection must be made greater. The plain weave consists of one end and one pick each way, and to enlarge on this arrangement the number of ends and picks must be increased. It is obvious that the next change would be two ends and two picks each way. This produces the simplest basket weave which can be constructed, shown in Fig. 119, of which Fig. 120 is an enlarged section of a fabric woven on this weave. This basket is the "two and two."

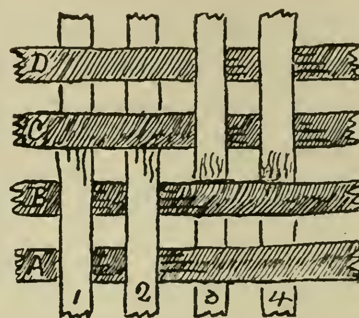


Fig. 120.

Make designs for example 1, 3 and 3; example 2, 4 and 4; example 3, 5 and 5.

FANCY BASKET WEAVES.

From the plain or common basket weaves the fancy baskets are constructed. These are solely the combination of two or more weaves of the common basket, or a basket and the plain combined.

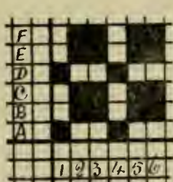


Fig. 121.

Fig. 121 is an illustration of these weaves, combining the plain and the two basket, to form a weave which repeats on three ends and three picks. Fig. 120 shows the combination of a more complicated weave of this class, being the one, two and three combined, and consisting of three changes. It repeats on twelve ends and twelve picks.

In designing these weaves commence at the left-hand corner and run the weave across the square paper to the upper right-hand square. Two repeats of the original weaves are necessary before a complete repeat of the weave is secured. After designing these on the paper fill in the rest of the weave, always counting the changes, the same both warp and filling way.

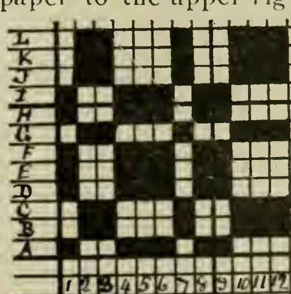


Fig. 122.

Combine the following in fancy basket weaves:—Example 4, 2—4; example 5, 1—4—2; example 6, 2—3—1—2—1; example 7, 1—1- 2—2—3; example 8, 2—3—4.

BASKET WEAVES.

1. From what weaves are common basket weaves derived?
2. Make a design and diagram of the simplest basket weave.
3. What is this weave called?

FANCY BASKET WEAVES.

4. How are fancy basket weaves constructed?
5. Combine the plain weave and "two and two" basket.
6. Give the method of designing fancy basket weaves.
7. How do fancy basket weaves designed from an even number of changes differ from those designed from an odd number of changes? Describe fully.

SATEEN WEAVES.

Satin. Real satin is a silk fabric in which the warp is allowed to float over the filling in a manner covering it entirely and presenting a smooth lustrous face, Fig. 123.

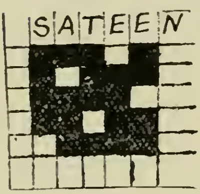


Fig. 123

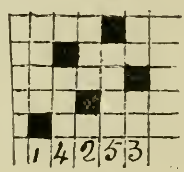


Fig. 124.

Satinet is a mixture, or union cloth, in which the face shows only a woolen filling, the cotton warp being covered by the filling. It is a cheap imitation of satin. See Fig. 124. In some districts this is known as "Kentucky Jean."

These weaves produce what there name implies, a satin effect. They are very extensively used in cotton, linen and silk goods, also in woolen and worsted fabrics. In the manufacture of damask and linen table covers they form nine-tenths of the product. In cotton goods they are used for making stripes, and in woolen goods they form what are called venetians, doeskins, beavers and kersey weaves. They are constructed usually from a twill weave, and this principle of interweaving is sometimes employed where the object is partly ornamental, as in satins used largely for trimmings and for ladies' dress goods. In such cases the first object is to produce a highly lustrous surface, perfectly smooth and showing no pattern.

If one class is taken as typical, in order to point out the peculiar arrangement and its effects upon the fabric, it may serve as a guide when dealing with patterns for ornamentation.

These weaves are of two distinct classes, those in which the warp predominates on the face being called the warp flush sateen, and those in which the filling predominates on the face being called the filling flush sateen.

The peculiarity of these weaves is that the order of interweaving the two sets of threads does not follow consecutively, but at definite intervals, special care being taken that at no point do they follow consecutively.

An example of the simplest kind, and one most commonly employed, is derived from the five-harness common twill (Fig. 125), where the filling predominates on the face, running to the right at an angle of 45 degs., and consecutively 1, 2, 3, 4, 5, changing this weave over to a sateen weave (Fig. 126), it will be observed that the order of interweaving is at set intervals.

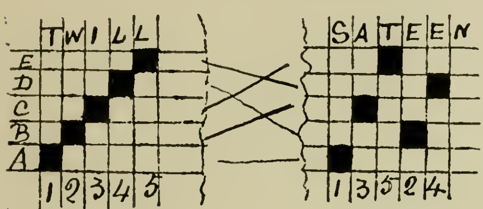


Fig. 125. Fig. 126.

To obtain the combination for the designing of a sateen: Take the number of harnesses of the original twill-weave on which it can be woven, and divide that number into two parts, which must be neither equal nor one the multiple of the other, nor must they be divisible by a third number. In constructing the weave (Fig. 126) in accordance with the rule, five, the number of harnesses on which the twill (Fig. 125) is woven, is divided into two parts, which are two and three.

To construct the weave to form the sateen from these two figures, the method is to use either two or three as the number to count off with. If three is used, it will be found that the picks of the twill would be used in the following order: A, D, B, E, C, which produces the sateen weave shown at Fig. 126. This is the filling flush sateen and the reverse or warp flush weave as shown in Fig. 127. This is constructed after the same manner as the filling flush weave, except the one down and four up warp flush weave is used.

Fig. 127.

From a six-harness twill no regular sateen can be made, the number of harnesses not being divisible according to the rule. An irregular weave can be produced, but it is not desirable, as there

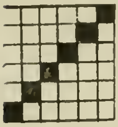


Fig. 128

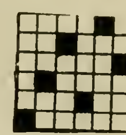


Fig. 129.

will be two threads or two picks running consecutively in some parts of the weave. The best combination is made by using the threads of the twill in the following order, 1, 3, 5, 2, 6, 4. See figures 128 and 129. Seven harness sateen can be obtained according to rule. See Fig. 130 and Diagram 131.

As a further demonstration, take the eight harness filling flush twill, one up and seven down. Fig. 132.

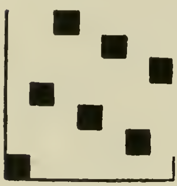


Fig. 130.

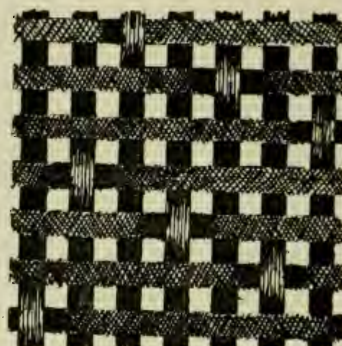


Diagram 131.

According to rule, divide the twill into two parts of unequal numbers, three and five. Four and four would be equal, six and two would be divisible by a third number. To have a thorough knowledge and understanding, take the twill and study every pick; take three as the number to count off with.

The first pick of the sateen will be the first pick of the twill; the second pick is found by adding three to the first pick, which makes it the fourth pick of the regular twill; then adding three to four, makes it the seventh pick of the twill; to this seven three is added, which shows that the fourth pick of the sateen is the tenth of the twill, but as the twill repeats on eight picks, the second corresponds to the tenth and is the fourth of the sateen; to the second pick three is added, which makes the fifth of the twill and also the fifth of the sateen; to the fifth three is added, which makes the eighth of the twill the sixth of the sateen; to the eighth three is added, which makes eleven, the third pick is equivalent to the eleventh and seventh of the sateen; to the third

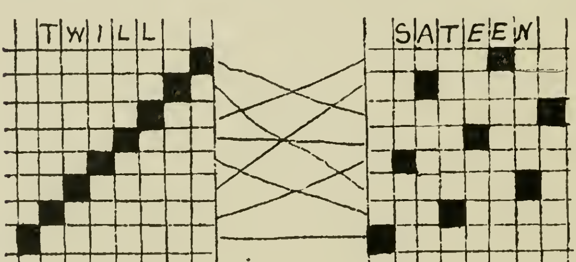


Fig. 132. Fig. 133.

three is added and so the sixth of the twill is the eighth of the sateen; if three is again added, the first pick of the twill will be the next one to be used, which will show that the repeat of the weave has been obtained. The eight-harness sateen is formed by using the picks of the twill in the following order: 1, 4, 7, 2, 5, 8, 3, and 6. See Fig. 133.

In laying out a cloth of this description, the number of threads either in warp or filling is of the greatest importance. The warp threads in a warp-flush weave should be placed as close together as their diameters will permit. As the filling is inserted, one thread will be withdrawn from the surface of the fabric and will bend round the filling at the back. As the next pick is inserted a different thread will be withdrawn, the first one returning to its original position. As the threads are not withdrawn in regular or consecutive order the filling does not bend round the warp in a great degree, but remains straight, the warp only being drawn out of its course. That being so, the filling threads cannot be laid close together, but will always be separated from each other by at least the diameter of the warp thread; therefore, there should be a greater number of warp threads per inch than filling picks.

If the fabric is for a useful purpose, as well as to bear strain, the material which is present in least quantity, whether it be filling or warp, should be of sufficient strength to compensate for the absence of quantity, otherwise the fabric will be able to bear strain in one direction only, whereas by proper attention to the strength of the material employed we may make it able to bear the requisite strain in both directions. If it is desired to produce on the fabric a smooth unbroken surface, with no pattern visible, the warp threads may be placed so closely together that as one is withdrawn to bend round the filling those on each side of it will close over the vacancy and completely hide the point where it was interwoven with the filling. In that case the number of warp threads would be increased in proportion to the number of filling, and consequently the fabric will be capable of bearing an increased strain upon the warp, but a decreased strain in the direction of the filling. Exactly the same principle will apply to fabrics where a filling surface is desired, the warp threads being set such a distance apart as will permit of the filling threads passing readily between and bending around them.

The filling threads are inserted as closely as their diameters will allow, and in some cases so as to pass over and hide the point where filling has bent around the warp, and again, in many cases, so closely that the filling is compressed and loses its cylindrical form. In such fabrics the greatest strength is in the direction of the filling in proportion to the quantity of material employed.

EXERCISES IN SATEEN MOTIFS.

(*A*) Work out weaves from the following:

(1) $\frac{3\quad 2\quad 3}{2\quad 1\quad 1}/1$ (2) $\frac{2\quad 2\quad 2}{2\quad 1\quad 2}/5$ (3) $\frac{1\quad 2\quad 3}{1\quad 2\quad 3}/1$

(4) $\frac{1\quad 2\quad 3}{1\quad 2\quad 3}/5$ (5) $\frac{2\quad 2\quad 2}{1\quad 1\quad 4}/1$ (6) $\frac{2\quad 2\quad 2}{1\quad 1\quad 4}/5$

(7) $\frac{3\quad 3\quad 1}{3\quad 2\quad 2}/1$ (8) $\frac{3\quad 3\quad 1}{3\quad 2\quad 2}/2$ (9) $\frac{3\quad 3\quad 1}{3\quad 2\quad 2}/3$

(10) $\frac{3\quad 3\quad 1}{3\quad 2\quad 2}/4$ (11) $\frac{3\quad 3\quad 1}{3\quad 1\quad 2}/5$ (12) $\frac{3\quad 3\quad 1}{3\quad 2\quad 2}/6$

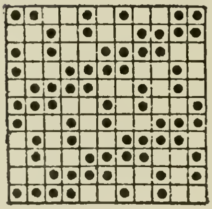
(13) $\frac{2\quad 2\quad 2}{1\quad 1\quad 3}/1$ (14) $\frac{2\quad 2\quad 2}{1\quad 1\quad 3}/2$ (15) $\frac{2\quad 2\quad 2}{1\quad 1\quad 2}/3$

(16) $\frac{2\quad 2\quad 2}{1\quad 1\quad 3}/4$ (17) $\frac{2\quad 2\quad 2}{1\quad 1\quad 3}/5$ (18) $\frac{3\quad 3\quad 1}{1\quad 2\quad 2}/5$

(19) $\frac{3\quad 1\quad 1}{2\quad 1\quad 2}/3$ (20) $\frac{4\quad 2}{2\quad 2}/2$ (21) $\frac{3\quad 1\quad 1}{1\quad 3\quad 1}/-3$

(22) $\frac{3\quad 3}{2\quad 4}/-5$ (23) $\frac{3\quad 3}{2\quad 4}/2$ (24) $\frac{3\quad 3}{2\quad 3}/-3$

(*B*) Write the order of weaving, and move numbers for each of the following weaves 25—30, both warp way and filling way.



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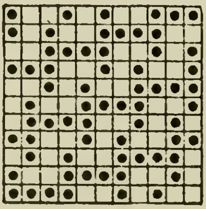

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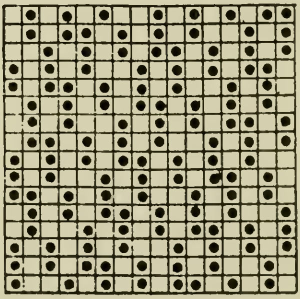

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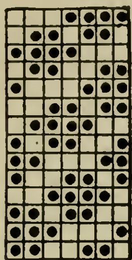
(Exercise continued on next page.)



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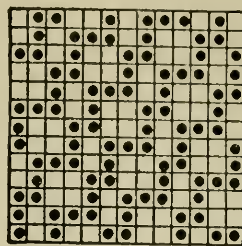

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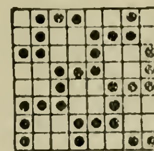

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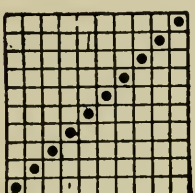
(*C*) Make plans with bases 31—33 and order of weaving $\frac{4\ \ \ 2}{\ \ 2\ \ \ 2}$ and with bases 34—38 and order of weaving $\frac{4\ \ \ 1\ \ \ 1}{\ \ 1\ \ \ 3\ \ \ 1}$



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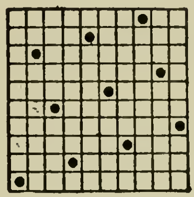

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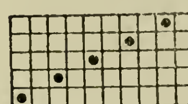

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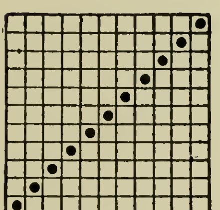

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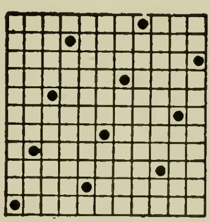

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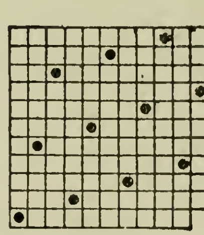

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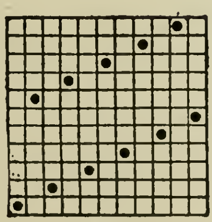
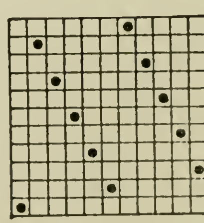


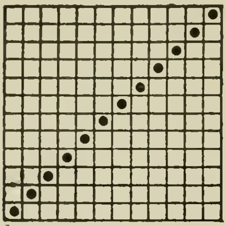
37



38

(Exercise continued on next page.)

(*D*) Make two plans on each of the accompanying bases 39—41.



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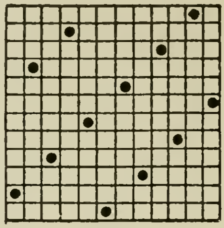

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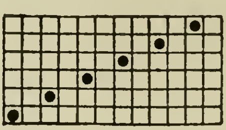
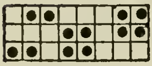


41

(*E*) Run out plans 42—45 to one complete pattern of each.



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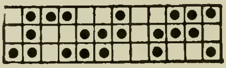

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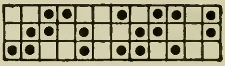

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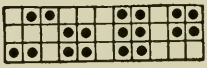


45

(*F*) Give two bases on 13 threads and run out two plans on each base

(*G*) Make plans as follows:

(1) $\dfrac{4 \quad 1 \quad 1}{\quad 2 \quad 2 \quad 2} \Big/ 3 - 1$ (2) $\dfrac{4 \quad 1 \quad 1}{\quad 2 \quad 2 \quad 2} \Big/ 4 - 2$

(3) $\dfrac{4 \quad 1 \quad 1}{\quad 2 \quad 2 \quad 2} \Big/ 5 - 3$ (4) $\dfrac{2 \quad 2 \quad 2}{\quad 1 \quad 1 \quad 4} \Big/ 2 + 0$

(5) $\dfrac{2 \quad 2 \quad 2}{\quad 1 \quad 1 \quad 4} \Big/ 3 - 1$ (6) $\dfrac{2 \quad 2 \quad 2}{\quad 1 \quad 1 \quad 4} \Big/ 4 - 1$

(7) $\dfrac{2 \quad 2 \quad 2}{\quad 1 \quad 1 \quad 4} \Big/ 5 - 3$ (8) $\dfrac{3 \quad 2 \quad 2}{\quad 2 \quad 1 \quad 2} \Big/ 5 - 1 - 1$

(9) $\dfrac{3 \quad 2 \quad 2}{\quad 2 \quad 1 \quad 2} \Big/ 3 - 2 + 2$ (10) $\dfrac{3 \quad 2 \quad 2}{\quad 2 \quad 1 \quad 2} \Big/ 4 - 3 + 2$

(*H*) Give order of weaving and move of the following plans:

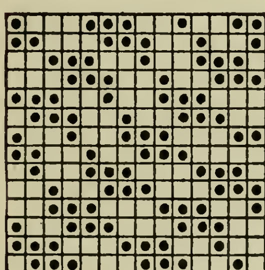
(11) $\frac{3\quad 2\quad 2}{\quad 2\quad 1\quad 2}\Big/ 4-2+1$ (12) $\frac{2}{\quad 2}\Big/ 0+2$

(13) $\frac{3}{\quad 3}\Big/ 0+0+3$ (14) $\frac{3}{\quad 3}\Big/ 0+3$

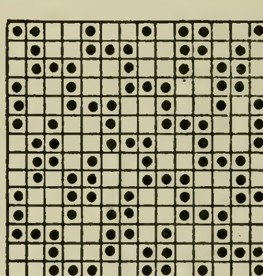
(15) $\frac{3\quad 1\quad 1}{\quad 1\quad 3\quad 1}\Big/ -1+3$ (16) $\frac{3\quad 1\quad 1}{\quad 1\quad 3\quad 1}\Big/ -3+5$

(17) $\frac{4\quad 1\quad 1}{\quad 2\quad 2\quad 2}\Big/ 5-1-1$ (18) $\frac{3\quad 2\quad 1}{\quad 3\quad 2\quad 1}\Big/ 5-1-1$

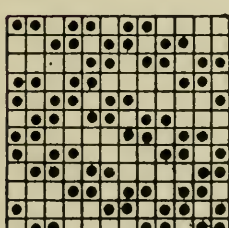
(19) $\frac{2\quad 2\quad 2}{\quad 1\quad 1\quad 4}\Big/ 5-1-1$ (20) $\frac{1\quad 3\quad 1}{\quad 1\quad 1\quad 5}\Big/ 5-1-1$



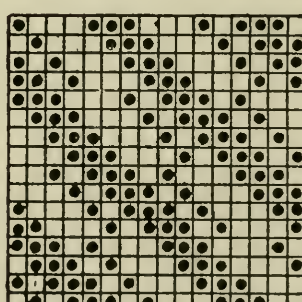
A



B



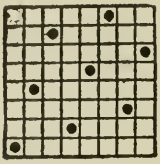
C



D

(Exercise continued on next page.)

(*I*) Make two plans on each of the accompanying bases 21—30.



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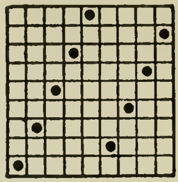

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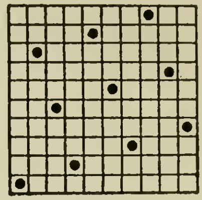

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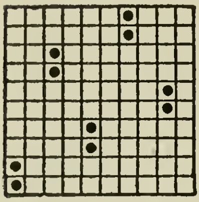
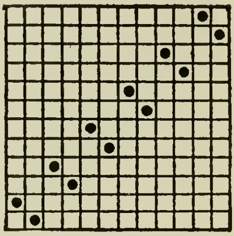


24



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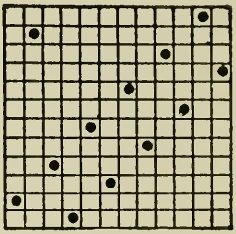
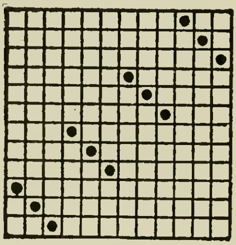


26



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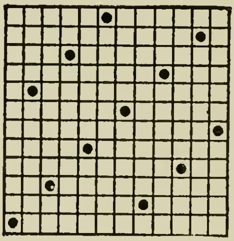

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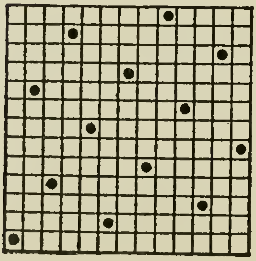

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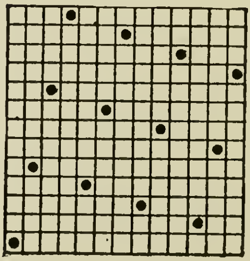
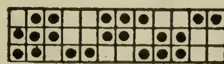


30

(Exercise continued on next page.)

(*J*) Run-out plans 31—36 until complete.

31



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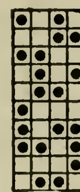
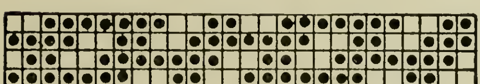


36

(*K*) Give one complete repeat of plans 37—43 and write order of weaving and move number for each.



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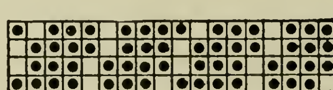

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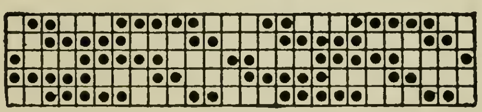
39



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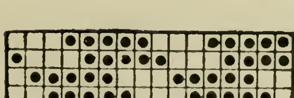

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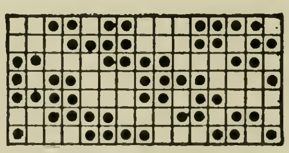

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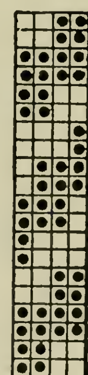


40

SATEEN STRIPES.

In designing fancy fabrics for the white cotton trade the designer is frequently compelled to depend almost entirely upon the weave to obtain different effects. When the warp and filling are both white, this becomes a necessity. There is another method, however, and it is one that is often useful, namely, the manner in which the warp is reeded. In some patterns it is necessary to have some parts of the warp reeded in greater numbers than in other sections, that is, in some parts of the reed each dent contains 2 threads, while in other sections the reed may contain 3, 4, 5 or even 6 in one dent. Six is generally considered the highest number, but in some rare cases even 8 or 10 threads are put in the same dent.

Nearly all the fancy white goods that are made have for the body or groundwork of the fabric the regular plain or cotton weave, 1 up and 1 down. The stripe in the warp will be either a twill, broken twill, or sateen weave, warp flush, and the overcheck will be a sateen weave, filling flush. The sateen weave is generally combined with other weaves to make stripes and checks.

Stripes consist of bands or lines, varying in width and color, running lengthwise of the cloth, viz., in the direction of the warp. The distinctive character of this make of goods is its line-like composition. All patterns of this order are nothing more than a blend of lines of various shades and weaves. They are of varying widths and extend from one end of the fabric to the other. Although this form of pattern is well adapted to trouserings, shirtings, and some styles of dress and mantle cloths, it is not suitable for coatings and even suitings when extended beyond a very minute stripe of the hair line description.

The variety of these stripes is very extensive, both as to shade and color, commencing with a single thread hair line, and increasing in size until a stripe or band several inches wide is obtained.

The prominence of the different weaves employed, the bands or lines of color, their distinctness, solidity, their intermittent character, and their subdued tone aspect, are all qualities depending on the structure of the fabric and its weave composition.

The pattern in striped styles is principally a warp product, and the filling in such cases only of secondary consideration. The filling is employed, first, to bind the warp threads together

and thus form a wearable fabric; second, to constitute an appropriate groundwork on which the warp colorings may be correctly exposed.

Proper emphasis of the colors composing the stripes is acquired by employing a suitable shade of filling, and by adopting that system of crossing or interweaving which will, in addition to yielding the requisite strength and firmness of fabric, sufficiently interfere with the continuity of the fancy shades introduced into the warp.

Some are mere lines, no wider than the diameter of the threads employed, while others are several inches wide. Two colors may be introduced to form stripes of different widths; for example, black and a dark mix may be combined to give stripes of many descriptions.

We could use 1 thread of black and 1 thread of dark mix, which would make a stripe of the hair-line description, using the plain weave for the intercrossing; or 2 threads of black and 1 thread of dark mix, using the 3-harness twill for the interweaving. Thus we might continue on these principles and form sets of stripes of variable widths or sizes. The character of these styles to a very great extent is governed by the class of texture in which they appear. Examples of this occur in the various fabrics produced by the loom. Take, for example, stripes for trouserings, which are generally small to medium size, softly and neatly toned in coloring. In dress goods, mantlings and ulsterings are found much broader effects, more elaborate in arrangement, and which require much greater force of coloring.

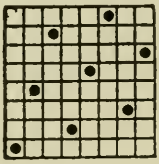
In cotton shirtings small, neat styles are considered the best, but in cotton dress goods there seems to be no definite limit, either as to the width of the stripe or to the radical plan of coloring. For aprons, children's dress goods and such fabrics as tickings and awnings, stripes are used to a considerable extent. To form a practical idea of what is meant by a sateen stripe the following particulars should be thoroughly understood.

Sateen Tick Stripe. When the name "Sateen Tick" is used, the general impression is that of a line of goods or a fabric which in some way resembles a sateen. But a sateen tick is in no way like a satin, being used for an entirely different purpose. These goods are made entirely of cotton, and are used for upholstery; the name "Sateen Tick" being taken from the weave, which is a sateen weave.

There is quite a demand for this fabric, but the manufacture of it is chiefly in the hands of a few large mills, which monopolize the industry. In many mills in which this fabric has been attempted a 2-ply yarn has been used for the warp, and this has made the goods harsh in feeling, and unfit for this purpose. The only proper way to make them feel soft is to use combed cotton yarn for the warp and the same stock for the filling, but having the filling twisted harder than the warp. The best fabrics on the market have 98 threads to the inch of single 7's and about 52 picks of single 14's. The weave which is used, and from which the fabric obtained its name, is the sateen weave, warp flush which throws the warp entirely on the face. It makes a smooth face, free from twill lines, with the points of intersection evenly distributed. The 5-harness sateen is the simplest kind. As before stated these weaves are constructed by taking the number of harnesses to be used for the sateen, and dividing it into two parts neither of which are equal, nor one a divisor of the other; still further, neither divisible by a third number.

The stitching for the weave, or the interlacing of the warp, is obtained in the following manner:

The first intersection will be on warp thread No. 1; the next intersection will be either on the third or fourth warp thread, according to whether the weave is counted by twos or by threes. If counted by twos the intersections will be as follows: 1, 3, 5, 2, 4. Almost all of these goods are woven on this weave, but in some cases the eight-harness sateen shown in Fig. 133 is used. The intersections are as follows: 1, 4, 7, 2, 5, 8, 3, 6. This is constructed on the same principle as the five-harness sateen, but there are fewer intersections of the warp; consequently this allows more picks and makes a heavier fabric. These sateens are very desirable goods, as they may be woven easier and faster on account of the weave. The line of colors should be as simple as possible, because the fewer the colors the less the expense. The following is a line of colors in use in one of the largest mills in the country: Black, white, red, very light tan, medium tan, dark blue, brown and light brown. These colors, if made in light shades, can be combined in a great variety of effects and produce innumerable patterns.



8 H. Sateen.

The following will give good results and splendid combinations, and will also give the size and style of the stripes. An

attractive effect having a very broad stripe can be produced by 120 threads of red, 10 white, 60 light tan, 4 dark blue, 10 medium tan, 4 dark blue, 60 medium tan, 4 dark blue, 10 medium tan, 4 dark blue, 69 light tan, and 10 white.

This can be varied and will make another very effective style by using 120 threads of dark blue in place of red, the rest remaining the same. Another good coloring is made as follows: 10 threads red, 10 dark blue, 88 red, 10 dark blue, 10 red, 50 white, 6 dark blue, 10 dark tan, 6 dark blue, 10 dark tan, 6 dark blue, 10 dark tan, 6 dark blue, 50 white, 2 dark blue, 16 red, 2 dark blue, 50 white.

In all these dressings the color can be varied; the number of threads may also be increased or decreased at pleasure. The principle effect desired is contrast of color, combined with harmony. There is no limit in the range of design.

COTTON SATEEN STRIPE.

The yarn used for this class of fabric varies from 40's to 70's, although a large proportion is between 50's and 60's. There are also large quantities of 2 ply, 4 ply, and sometimes 6 ply yarn used in cotton cords and stripes. The filling for such goods will range from 60's to 90's.

The texture of the fabric in the plain part, that is, the part between the sateen stripes, will vary from 60 threads x 60 picks to 96 threads x 80 picks. The width of the goods is generally from 27 to 28 inches, though goods made especially for aprons will run from 40 to 42 inches.

For an illustration, let us make a cloth 28 inches wide, having for the design a sateen stripe, with plain stripe ground for 1 inch; sateen or broken six-harness twill, ¼ inch; plain ground, ¼ inch; broken twill, ¼ inch. Total width of stripe to be 1¾ inches.

28 inches ÷ 1.75 inches = 16 repeats or designs across the cloth. Suppose we make the body of the warp, or what we have already called the plain or ground work, 80 threads to the inch. Then we have:

¼ inch broken twill
¼ inch groundwork
¼ inch broken twill
1 inch groundwork

It is to be divided into a reed with 40 dents to the inch, or, as is usually understood, a 40's reed; 2 threads in one dent = 80 threads per inch. When making a pattern with one part of the

design larger than the other, divide the larger portion into two parts, so that the design will commence at one side of the cloth and will be equal to the design at the extreme edge or other side of the cloth. Our typical design has one inch of plain or ground which we divide into two equal parts.

The way to lay out this piece of cloth will be as follows:

½ inch plain	20 dents	2 threads in one dent =	40 threads
¼ inch stripe	10 dents	6 threads in one dent =	60 threads
¼ inch plain	10 dents	2 threads in one dent =	20 threads
¼ inch stripe	10 dents	6 threads in one dent =	60 threads
½ inch plain	20 dents	2 threads in one dent =	40 threads
	70		220

Thus it will be seen that one pattern occupies 70 dents, and as we have already decided that there are to be 16 repeats of the pattern, we shall require 16 x 70 = 1,120 dents exclusive of selvedge. Add 10 dents on each side for selvedge, this making total of 1,140 dents.

1,140 dents ÷ 40 = 28½ inches.

The reed must be 28½ inches wide.

Two hundred and twenty threads in one pattern x 16 = 3,520 threads. The selvedge is composed of 20 double threads, 2 in a dent on each side.

Left selvedge 20 double threads =	40
Body of warp =	3,520
Right selvedge 20 double threads =	40
Total number of threads =	3,600

Fig. 134 represents a good weave for a six-harness broken twill. This weave is especially recommended for this purpose.

The next thing to make is the drawing-in draft, or harness draft and chain.

Also leave for selvedges 10 empty heddles on the right and left sides of the 4-front harnesses.

The first 40 threads on the 4-front harnesses, which are forming a plain weave; the second section of threads which are drawn on the 6 back harnesses, and are weaving a 6-harness broken twill; the third section of the threads which are drawn on the 4 front harnesses; the fourth section of threads, which are drawn on the 6 back harnesses; and the last section of 40 threads on the 4 front harnesses, make

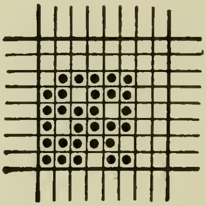


Fig. 134.

one repeat of the pattern or 220 threads. This operation is repeated 16 times, and when finished will have completed the body of the warp, or 3,520 threads. Now draw in the double threads

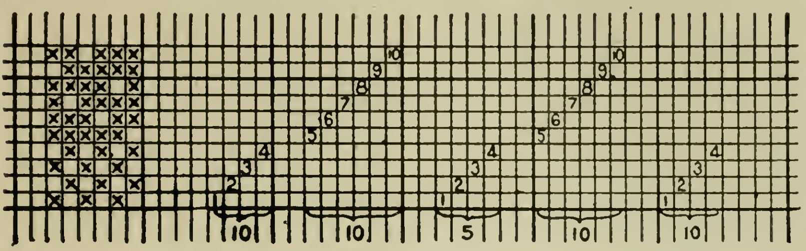


Fig. 135. Fig. 136.

for the selvedges on each side of the warp. The foregoing is a systematic way of obtaining the layout of a design, chain and harness draft; but in some mills the drawing-in or harness draft would be laid out as follows:

	10 double	threads on 1, 2, 3, 4.	for selvedges
Repeat 16 times	40	threads on 1, 2, 3, 4.	for plain weave
	60	threads on 5, 6, 7, 8, 9, 10	for broken twill
	20	threads on 1, 2, 3, 4.	for plain weave
	60	threads on 5, 6, 7, 8, 9, 10	for broken twill
	40	threads on 1, 2, 3, 4.	for plain weave
	220 x 16		
	10 double	threads for 1, 2, 3, 4.	for selvedges

There is another very important matter to which particular attention must be paid; that is, the question of how many wires or heddles must be placed on each harness shaft, thus preventing any possibility of overcrowding the wires or heddles on any or all of the harnesses. Take our previous example for illustration.

On the 1st harness	25 threads × 16 patterns	=	400 heddles
On the 2d harness	25 threads × 16 patterns	=	400 heddles
On the 3d harness	25 threads × 16 patterns	=	400 heddles
On the 4th harness	25 threads × 16 patterns	=	400 heddles
On the 5th harness	20 threads × 16 patterns	=	320 heddles
On the 6th harness	20 threads × 16 patterns	=	320 heddles
On the 7th harness	20 threads × 16 patterns	=	320 heddles
On the 8th harness	20 threads × 16 patterns	=	320 heddles
On the 9th harness	20 threads × 16 patterns	=	320 heddles
On the 10th harness	20 threads × 16 patterns	=	320 heddles
			3,520 heddles
Also on the 4-front harness 5 extra for selvedges			20 heddles
	Total		3,540 heddles

In this cloth we will suppose there are 72 picks per inch.

In weaving this class of fabric, there is often much trouble caused by filling kinks. The filling is apt to catch on the sateen stripe, and unless the shed is perfect and clear there will be trouble of this kind. Under these circumstances it is necessary that the harnesses are properly hung, and that they are making a clear, even, open shed. Almost all mills engaged in weaving this class of goods use a head motion known as the dobby. The Crompton, Knowles and Stafford being the most popular. As the goods are woven with one shuttle the looms can be run at a very high rate of speed, for which the dobby or head motion is especially adapted. These dobbies are made to fit any kind of loom, and it is quite common for mills to put them on their plain looms, to be used thereafter for fancy weaving. But as the loom can weave with but one shuttle, it is confined to striped goods.

Overchecks. In making patterns for plaids, proceed in the same manner as with the stripes to find the number of warp threads. It is the filling check or overplaid that will give most of the trouble in these patterns.

To get the stripe or overcheck in the filling of the same density as the broken twill or sateen stripe in the warp, the take-up motion must be prevented from working, so that the filling threads may be beaten up closely, to correspond with the broken twill in the warp. To accomplish this a wire is attached to the pawl that pushes or pulls the rachet gear, and is fastened at the other end to one of the levers that work the harnesses. Wherever the take-up motion should stop, a pin is inserted in the chain at the proper place. The pin, in lifting the lever, pulls the wire that is fastened to the pawl, thus lifting it up and thereby stopping the take-up motion.

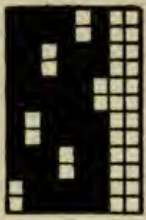


Fig. 137

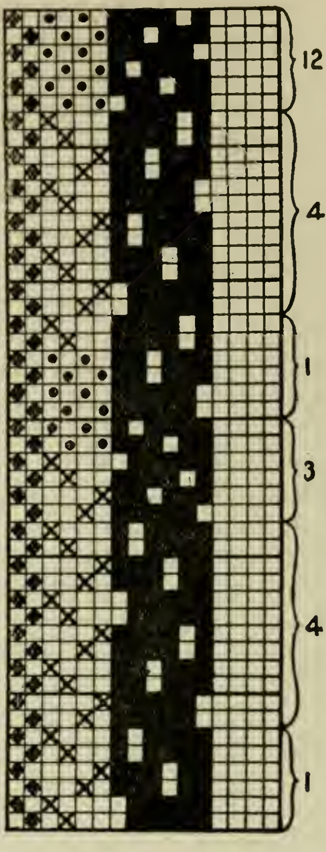


Fig. 138.

The question now arises of how often the take-up motion should be stopped while weaving the check.

We will again take our example: to make the filling compare with the warp, there will need be as many picks in ¼ inch as there are in the corresponding stripes in the warp, which is 60. It will be found, however, in practice, that 54 will be sufficient. Supposing there are 72 picks per inch, in ¼ of an inch there would be 18, but the overplaid calls for 54. The ratchet gear is taking up 1 tooth every 2 picks, thus moving 9 teeth for every ¼ of an inch of cloth woven; therefore, to get 54 picks in that space, there must be 6 picks for every tooth taken up, so it follows then that out of every 6 bars in the pattern chain, 4 of them will have to contain pins in order to stop the take-up motion.

The best weave for the stripe or overplaid, when there are an even number of threads in a dent, is the 4-harness broken twill, or crowfoot weave. In making the design for a filling stripe of this description, and in order to have the warp stripe pass smoothly over the filling check, the weave must be made double what it is in the plain part; if we are using a 5 up and 1 down weave, it must be made to run exactly double, that is, 10 up and 2 down, when it comes to the filling stripe. Fig. 137 will explain.

There must be two extra harnesses allowed for selvedges on patterns of this nature, otherwise there will be a bad selvedge where the filling stripe is being woven. Fig. 138 shows the harness chain complete for weaving a plaid from a stripe pattern just explained.

SHADED FABRICS.

Shaded fabrics are often in demand, used not only in decorative Jacquard work in general, but also in men's wear and dress goods. Shading may be done in two ways. 1, by using different colors of yarn in warp and filling and changing the weave, or 2, by shading the colors from light to dark and using the same weave throughout the pattern. In the first instance, there would be a light warp with a dark filling. The reverse would produce a similar effect. When a dark filling and a light warp is used, a filling flush weave is used for the darker portion of the fabric and gradually changed to a warp flush to procure the desired effect of shade. This may be done by adding extra risers to the original filling flush weave. The original filling flush weave or base weave may be either a twill or a sateen. The base weave is carried to the full extent of the design. The different portions of the shaded design then outlined and the slightly varying weaves are placed in their proper positions, according to the density of shading required.

SATEEN WEAVES.

1. Define the following terms: (*a*) satin, (*b*) satinet, (*c*) Kentucky Jean.
2. What fabrics are woven from satin effects?
3. Describe the uses of satin effect in cotton and woolen goods.
4. What weaves are used as foundations for sateen weaves?
5. Define the difference between a warp flush and filling flush sateen.
6. What peculiarity exists in the interweaving of the warp and filling of a sateen weave?
7. What is the method used for "obtaining the combination for the designing of a sateen?" Describe fully.
8. Construct a five-harness sateen from the one up, four down twill, (*a*) using two as a move number; (*b*) using three as a move number.

9. How is a six-harness sateen constructed?

10. Give all the possible move numbers for the following sateen weaves: seven-harness, eight-harness, nine-harness, ten-harness, eleven-harness, twelve-harness, thirteen-harness, fourteen-harness, fifteen-harness and sixteen-harness.

11. Illustrate the method of constructing a sateen weave (pick by pick) by using the eight-harness one up, seven down, move number three.

12. When weaving a warp flush sateen, how close should the warp threads be set in the loom?

13. Describe fully the interweaving of warp and filling in a warp flush sateen.

14. Compare the strength necessary for warp and filling in a filling flush sateen.

15. How is a smooth, unbroken surface produced by (*a*) a warp flush sateen; (*b*) a filling flush sateen?

CORKSCREW AND DOUBLE TWILL WEAVES.

These weaves are chiefly used in the manufacture of worsted suitings and trouserings and in some branches of silk manufacture. They are similar to oblique warp effect rib weaves in that they require a fine or close sett, since the warp forms to a great extent the surface of both face and back of the cloth, the filling being merely embedded between alternate warp threads.

With reference to the theory of constructing this class of weave, the true corkscrew is constructed from the regular twill weaves on an uneven number of harnesses, by using the regular 45 degree twill for a chain and drawing the threads through the harnesses in the same order as the intersections would occur in any given sateen weave on that number of harnesses.

The regular 45 degree twill weave must have the warp section lifting one point in excess of the sinkers or filling section, thus: $\frac{3}{\;\;2} = 5$ threads, $\frac{4}{\;\;3} = 7$ threads, $\frac{5}{\;\;4} = 9$ threads, this is done so as to provide for the overlapping being equal at the junction of the corkscrew twill.

If the overlapping of floats at the juncture of the two twills is more than one point, the effect of this style of weave will be lost. This explains the reason why this method of drafting is impracticable on weaves of an even number of harnesses, as an even number cannot be divided into two unequal parts, one of

which will exceed the other by one point only. The fewest number of harnesses to make a corkscrew weave is the five-harness $\frac{3}{2}$ 45 degree twill; the thirteen-harness being the largest corkscrew weave in practical use.

Fig. 139.

Fig. 139 is the five-harness 45 degree twill. Operation: Divide the number of harnesses into two parts, one of which will exceed the other by one point or unit, thus 3 and 2 equal 5. The drawing-in draft is on the same principle as constructing a sateen weave, commencing with the first thread on first or front harness, using one of the numbers to count off with, as a move number, thus: first thread on first harness, second thread on fourth, that is, first and move three, will place the second thread on the fourth harness; fourth and move three, will place the third thread on the second harness; second and move three, will place the fourth thread on the fifth harness; fifth and move three, will place the fifth thread on the third harness; third and move three, places the sixth thread on the first harness which is the same as the first and determines one repeat of the weave.

This draft shows a straight draw for five harnesses, considering every other warp thread only, viz: every uneven warp thread, 1, 3, 5, 7, 9, etc., calling in turn respectively for the 1st, 2d, 3d, 4th and 5th harnesses; the even warp number two commences on the fourth harness, considering again every other warp thread only, viz: every even warp thread, numbers 2, 4, 6 and so on, calling in turn respectively for harnesses numbers 4, 5, 1, 2, 3. The draw or draft completed will read 1, 4, 2, 5, 3, 1, 4, 2, 5, 3. A study of Figs. 140 and 141 will explain. Explanation in detail:

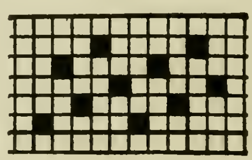


Fig. 140.

1st	thread	on	the No.	1	harness,	count off	3	places,	the
2d	,,	,,	,,	4	,,	,,	3	,,	,,
3d	,,	,,	,,	2	,,	,,	3	,,	,,
4th	,,	,,	,,	5	,,	,,	3	,,	,,
5th	,,	,,	,,	3	,,	,,	3	,,	,,
6th	,.	,,	,,	1	,,	,,	3	,,	,,
7th	,,	,,	,,	4	,,	,,	3	,,	,,
8th	,,	,,	,,	2	,,	,,	3	,,	,,
9th	,,	,,	,,	5	.,	,,	3	,,	,,
10th	,,	,,	.,	3	,,	,,	3	,,	,,

Fig. 141 shows the corkscrew weave carried to its full extent. It will be noticed that in the first half of the draft that the first or odd thread commences the draw, whereas in the second part of the draft it is the sixth thread or even number that commences the draw. The draft must be extended to double the original weave to make one full repeat.

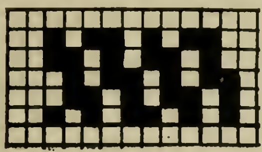


Fig. 141.

Fig. 142 is a seven-harness weave, seven divided into two parts, one of which will exceed the other by one point only, 4 and 3 equal 7. $\frac{4}{3}$ 45 degree twill.

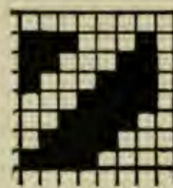


Fig. 142.

Fig. 143 represents the harness draft, and

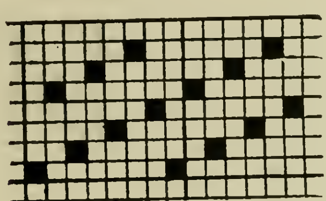


Fig. 143.

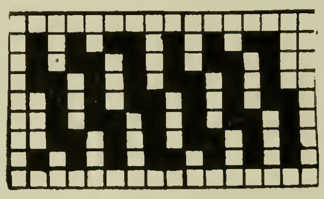


Fig. 144.

Fig. 144 is the extended design or corkscrew twill. Four is the move number.

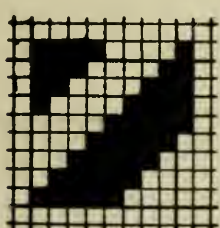


Fig. 145.

Fig. 145 is a nine-harness weave, nine divided into two parts, one of which will exceed the other by one point only, 5 and 4 equal 9. $\frac{5}{4}$ 45 degree twill, with 5 for the move number. Fig. 146 harness draft. Fig. 147 extended design.

Uneven balanced weaves will always produce more perfect corkscrew weaves than the even-sided twills, since it is only possible with the uneven-sided twills to balance the cut off of the double twill. The direction of the twill will be reversed by using the lesser number.

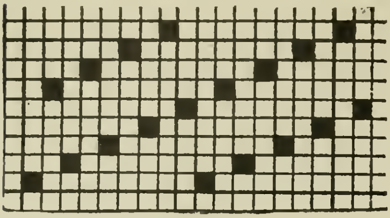


Fig. 146.

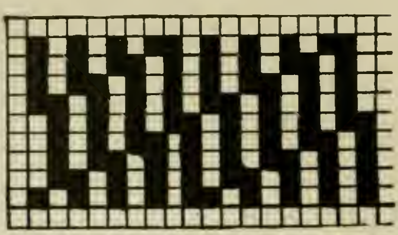


Fig. 147.

CORKSCREW WEAVES CONSTRUCTED ON AN EVEN NUMBER OF HARNESSES.

No matter which even harness 45 degree twill is used for foundation for an even harness corkscrew weave, the junction of the two twills will be faulty. There is not the equal cut off as produced with weaves having an uneven number of harness for repeat, but sometimes a corkscrew weave on an even number of harnesses is required, especially with fancy effects in which corkscrew weaves are used in combination with other weaves. For instance, a case may occur when a corkscrew weave for an even repeat of harness is required to connect with a six-harness twill.

Fig. 148.

Fig. 148 is the $\frac{3}{}\!\!\frac{}{3}$ 45 degree twill.

Fig. 149 drawing-in draft. Fig. 150 extended design.

It will be noticed that with this weave there is not the perfect junction when the two sections meet as there is in the five-harness weave. This is always with an even sided 45 degree twill.

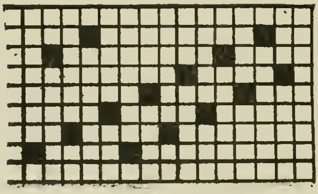


Fig. 149.

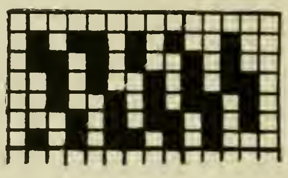


Fig. 150.

There is no true corkscrew weave on an even number of threads less than twelve; and this weave is composed of two six-harness twills, viz: $\frac{3}{}\!\!\frac{}{3}$ Fig. 151, and $\frac{4}{}\!\!\frac{}{2}$ Fig. 152, twills. To obtain the even cut off of the two twills, commence with the

first thread of the $\frac{3}{3}$ twill and the fourth thread of the $\frac{4}{2}$ twill, then take the threads alternately from each twill, thus, 1, 4, 2, 5, 3, 6, 4, 1, 5, 2, 6, 3, Fig. 153; this weave repeats on 12 threads and six picks, having a balanced cut off between the double twills, however, showing two slightly different sizes of twill effects, that is, a four float alternating with a three float.

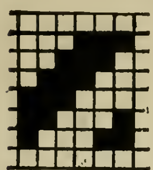


Fig. 151.

Again, such corkscrew weaves do not permit of a reduction of harnesses, which is a serious defect. The above example cannot be reduced to less than twelve, whereas the uneven number corkscrew weave can be reduced to the number of the original 45 degree twill.

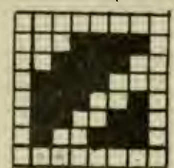


Fig. 152.

When corkscrew weaves are made from weaves exceeding nine threads and picks the interlacing of warp and filling is very loose, so that the fabric is not merchantable, as the warp will slip off the filling. To remedy this without changing the face of the fabric, the warp floats upon the back must be reduced by adding one or more points of interlacing.

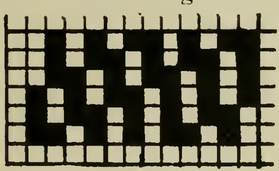


Fig. 153.

Take an eleven-harness 45 degree $\frac{6}{5}$ twill. To change this twill so that it will bind firmly, the five sinkers which go to the back must be made to inter-

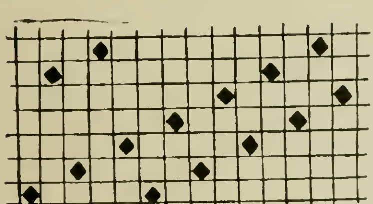


Fig. 154.

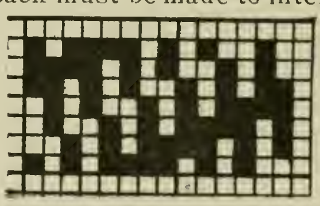


Fig. 155.

lace $\frac{1}{2\quad 2}$; this changes the 45 degree twill to interlace $\frac{6\quad 1}{2\quad 2}$ = 11-harness.

Figs. 154 and 155 illustrate the 7-harness weave constructed the wrong way. Compare these Figs. 154 and 155 with Figs. 143 and 144.

CORKSCREW AND DOUBLE TWILL WEAVES.

1. For what purposes are corkscrew weaves chiefly used?
2. What class of weaves do corkscrew weaves resemble in regard to sett?
3. What weaves are used as foundations for corkscrew twills?
4. What weaves do the drafts for corkscrews resemble?
5. Are the foundation weaves warp or filling flush? Why?
6. What is the effect if the overlapping is more than one point?
7. Are the foundation weaves generally on an even or odd number of harnesses?
8. Make a design for the simplest corkscrew twill.
9. What is the largest number of harnesses used for practical use?
10. Give a complete description of the method used for constructing corkscrew weaves.
11. Why is it necessary to extend the draft to double the original weave? Explain with an illustration of the five-harness corkscrew.
12. Give move numbers for corkscrew twills woven on the following number of harnesses: seven, nine, eleven, thirteen.
13. What advantage is gained by using uneven balanced twills for corkscrews?
14. How may the direction of the twill be reversed?
15. What defect is found when using an even harness twill for foundation?
16. How is an even cut-off obtained when using a weave on an even number of harnesses for foundation?
17. What is the defect in this method?
18. What defect is noticeable when corkscrew twills are made from foundation weaves exceeding nine threads and picks are used?
19. How may the defect in Question 18 be remedied?

CIRCULAR AND SPOT WEAVES.

Broken weaves on a limited number of harnesses are often required in the manufacture of figured cotton and silk fabrics. These weaves may be constructed by the so-called circular method, employing either one or two weaves. The number of different weaves that may be constructed from the same founda-

tion weaves is limited only by the combining qualities of the weaves used. Taking two three-harness weaves as an example: $3 \times 3 = 9 \times 4 = 36$ points of interlacing The resulting or circular weave repeats on 6 threads and 6 picks.

$$6 \times 6 = 36 \text{ points of interlacing.}$$

Two four-harness weaves will give $4 \times 4 \times 4 = 64$ points of interlacing.

The construction of circular weaves is simple. Fig. 151 is the four-harness swansdown twill, and Fig. 152 the four-harness crow weave. The first step is to find the size of the circular weave.

$$4 \times 4 \times 4 = 64. \qquad \sqrt{64} = 8. \qquad 8 \times 8.$$

Marking off 8 x 8 on the design paper, the first weave (swansdown) is placed on alternate threads and picks, as shown in Fig. 153. The second step is to turn the paper 90°, or quarter way around to the right, and place the second weave (crow) on alternate threads and picks. The result is shown in Fig. 154. Third step: Turn the paper 90°, or on alternate threads and picks, as in Fig. 155. The fourth and last step is to turn the paper 90°, or quarter way around to the right, placing the second weave (crow) on alternate threads and picks, giving the complete circular weave in Fig. 156. Turning the paper 90°, or quarter way around to the right, will give the first position, Fig. 157.

Figs. 158 and 159 are two four-harness foundation weaves, the several steps in the construction of the circular weave being shown in Figs. 160, 161, 162, 163, and 164. By combining Figs. 157 and 164 the circular weave in Fig. 165 is produced.

Taking the first foundation weaves used, the four-harness swansdown and crow, many different effects may be obtained by commencing either or both of these weaves on a different thread or pick.

Fig. 166 swansdown twill, commencing with the second pick.
,, 167 crow weave, first pick.
,, 168 resultant circular weave.
,, 169 swansdown twill, commencing with the third pick.
,, 170 crow weave, first pick.
,, 171 resultant circular weave.
,, 172 swansdown weave, commencing with the fourth pick.
,, 173 crow weave, first pick.
,, 174 resultant circular weave.

From this it may be seen that by changing the crow weave in a similar manner the number of effects may be greatly increased.

Circular weaves are used to a great extent as foundation weaves for crepes and similar fancy effects.

Nos. 1, 2 refer to foundation weaves, No. 3 resultant weave.

SPOT WEAVES.

Spot effects may be produced in a fabric either by a spot in the weave or by the use of an additional warp or filling to give the spot figure. The simplest method is by using a spot weave, which is constructed on the principles used for circular weaves.

Fig. 175 is the cassimere twill carried out eight threads and picks. Fig. 176 shows the same weave with risers removed in the order of an eight harness sateen. This is taken as a foundation weave. Combining these weaves as a circular weave the spot effect in Fig. 177 is produced.

A second method of constructing spot weaves is to mark off the paper the size required for the design and laying out a sateen weave. Around each of the sateen risers a figure is constructed so that a spot effect may be obtained. Fig. 178 illustrates an eight-harness sateen on a design 16 x 16. Fig. 179 is the same as Fig. 178 with a spot arranged on each of the sateen risers. Fig. 180 is a five-harness sateen spot arranged on 15 x 15. Fig. 181 is an eight-harness sateen arranged on 24 x 16.

A, B, C. Examples for analysis.

CIRCULAR AND SPOT WEAVES.

1. What governs the number of weaves possible from the same foundation weaves?
2. How is the number of points of interlacing found?
3. Give the number of points of interlacing in a circular weave formed from two four-harness foundation weaves?
4. For what purposes are circular weaves used?
5. Explain the first step in constructing a circular weave. Illustrate.
6. Explain and illustrate the second step.
7. Explain and illustrate the third and fourth steps.
8. Make a circular weave from the 2 and 2 basket and cassimere twills.
9. Make four different circular weaves from the foundation weaves used in Question 8.
10. How are spot effects produced?

11. What is the simplest method of producing a spot effect?

12. Design a spot effect from two cassimere twill weaves.

13. Illustrate the sateen method of producing spot effects by the following designs: eight-harness spot on twenty-four threads and twenty-four picks; five-harness spot on twenty threads and fifteen picks; seven-harness spot on twenty-eight threads and twenty-eight picks.

TWILLING.

Flushes. Diagonal twills or cords that run obliquely across the cloth may vary in size according to the number of harnesses on which they may be drawn in consecutive order. This manner of drawing is technically termed a straight over-draw. Twills are generally named according to the number of threads that will complete the design. This is technically termed a repeat. Thus, weave $\frac{1}{\quad 2}$ is known as a 3-harness twill, filling flush; the weave $\frac{2}{\quad 1}$ is called the 3-harness twill, warp flush. It may be stated here that when practicable, the smallest number of harnesses should be raised and the greatest number depressed in weaving special makes of cloth. In this manner the wear and tear of the yarn is much reduced; the only objection to this, being that in a warp flush face weave, the surface of the goods is woven face down and cannot be seen by the weaver.

The 4-harness twill, filling flush, is formed by the filling passing over 3 threads of warp and interweaving at the fourth thread. The 5-harness twill, warp flush, is formed by the filling passing over only 1 thread of warp, interweaving at the second thread and passing under 4 warp threads. The 5-harness twill, filling flush, is exactly the reverse of the warp flush. Fig. 156, plain weave; Fig. 157, 3-harness twill; Fig. 158, 4-harness twill; Fig. 159, 5-harness twill; Fig. 160, 6-harness twill. It should be understood that all marks, unless otherwise explained, are

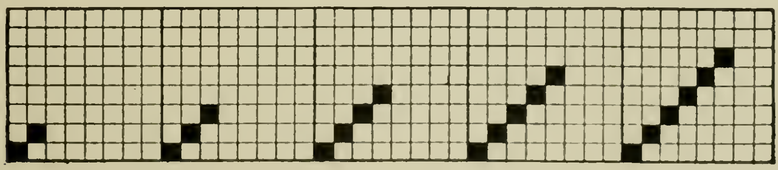


Fig. 156. Fig. 157. Fig. 158. Fig. 159. Fig. 160.

risers, and all blanks or spaces are sinkers: therefore, in Figs. 157, 158, 159, 160, the fillings predominate on the face and are called respectively 3, 4, 5 and 6-harness filling flush weaves. If the weaves had been reversed, that is, if crosses or black marks had been put in the squares which are now blank, the weaves would be warp flush weaves. We now understand a regular twill to run in small diagonal lines, bars or cords, at an angle of 45 degrees or obliquely across the frabric. It may be a filling flush, warp flush, or an even-balanced twill, according to the weave used.

When the consecutive lifting of the harnesses or scheme of successive interlacing with filling is changed, so as to raise the harnesses at intervals of 1, 2, 3 or more from each other, the twill or diagonal stripe is said to be broken, and it will be observed that the flushing does not run at an angle of 45 degrees, but is broken according to the intervals of interlacing and the disposition of the harnesses.

We must now consider this broken effect as compared with the regular disposition of the harnesses running in consecutive order. When the harnesses can be raised regularly, at intervals of 2, 3 or more from each other, the weave is said to be a sateen of a perfect order; but if the intervals cannot be so arranged, or the weave will not admit of this regular intermission, then the weave is not a true sateen, although we find many of these imperfect weaves forming the groundwork of many fabrics.

The smallest number of threads that can be arranged to make a true sateen is the 5-harness twill, the arrangement of which is 1, 3, 5, 2, 4. Six harnesses do not admit of such a disposition. The 7-harness twill is perfect, admitting an interval of 1 or 2 harnesses. Eight harnesses is the lowest number used in making an evenly numbered weave that can be transformed into a true sateen. By experimenting we find that by an interval of 2 we have a most perfect sateen. The 9-harness twill is perfect, each alternate harness lifting. The 10-harness twill is a good sateen, every third harness being raised. The same order of interweaving is shown by the 11-harness twill, which makes a perfect sateen. The 13-harness weave is formed by raising every third. The 15 is made by lifting every other third harness. The 16-harness sateen is made by omitting 2 or 4 threads. It may be remarked here that all twills of an uneven number, except the 3-harness twill, will produce perfect sateen arrangements. With the even numbers imperfections are often found. The pre-

ceding remarks apply either to the filling or warp flush weaves, where 1 thread is either up or down and the remaining number covered either by filling or warp.

Our next consideration will be *fancy twills*, or effects that are obtained by using any number of harnesses in any fixed weave. For instance, to make the 4-harness twill, 1 up and 3 down, into another variety or effect, we can take 2 up and 2 down. This is called the 4-harness cassimere or shalloon twill. With a larger twill the flushing can be varied by interspersing the weave with plain texture, as, for instance, the 7-harness changed to 1 up 1 down, 1 up 1 down, 2 up and 1 down, and so on.

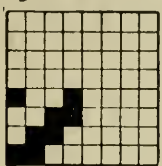


Fig. 161.

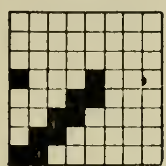


Fig. 162.

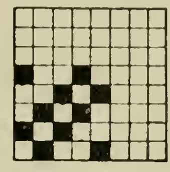


Fig. 163.

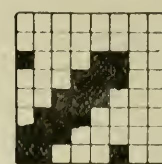


Fig. 164

Fancy Twills. Examples are here given (Figs. 161 to 170) of what are termed fancy twills, and it will be seen how an endless variety of patterns may be obtained from them.

Twills that run obliquely will form the groundwork for wave effects, either in the direction of the filling, across the fabric, or in the direction of the warp, that is, with the length of the fabric. Take, for example, the 4-harness twill, filling flush; draw this straight over on 4 harnesses and raise the harnesses as shown in Fig. 171. By studying this wave weave, we find that it is the common 45-degree twill for 4 picks and that it then twills to the left, thus: 1, 2, 3, 4, 3, 2, which makes a zigzag or wave effect in the direction of the warp. If we use the 4-harness $\frac{1}{3}$ twill and draw the threads through the harness, 1, 2, 3, 4, 3, 2 (see Fig. 172), which is the same order as given in the preceding example,

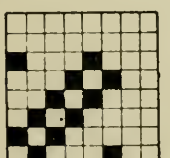


Fig. 165.

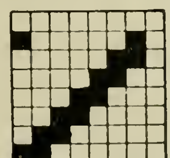


Fig. 166.

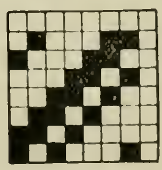


Fig. 167.

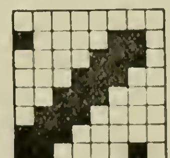


Fig. 168.

the effect or result in the fabric is a zigzag across the piece or in the direction of the filling.

Reverse Twills. In all the regular twills, as shown in Figs. 157 to 160, the filling predominates on the face of the cloth, and the warp on the back of the cloth. Take the 5-harness twill for an example; if the warp is of one color and the filling another, as there is 1 thread up and 4 threads down, it follows that four-fifths of the filling will be on the face and one-fifth on the back, thus changing the appearance of the filling from one side of the fabric to the other. This is called *reversing the twill.* It is very extensively applied in different branches of weaving, particularly in the cotton and linen trades. We will take for example the reversing of the 4-harness twill, and make a stripe of 12 threads warp flush and 12 threads filling flush. In this example (Fig. 173) we notice that it takes 4 extra harnesses, that is, 4-harness for the filling flush and 4-harness for the warp flush weaves. Patterns of this description may be extended to any width of stripe, as they are formed and regulated entirely by the quantity of warp drawn on each set of harnesses. These examples will be sufficient to show the nature of reversed twill stripes, the varieties of which may be increased at pleasure by means of additional harnesses, and by varying the size of one or both stripes.

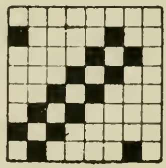


Fig. 169.

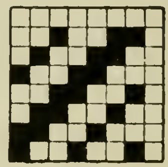


Fig. 170.

The next variation of the reversed twill is to form on the same stripe, the warp flush and filling flush effect alternately. (Fig. 174.) We find that there are 12 picks filling flush weave and 12 picks warp flush weave. We will now go a little farther with these examples, combining the two systems so as to make a checker or dice board effect. In making designs of this character, attention should be drawn to the divisions of the two weaves. Where they unite, the line must be distinctly defined, that is, to make them unite in a perfect cut. This will be better undertood by referring to Fig. 174, at the extreme sides of which, top

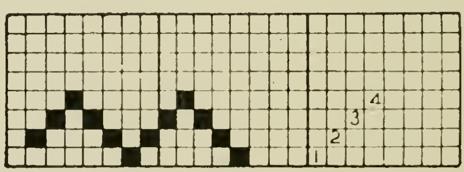


Fig. 171.

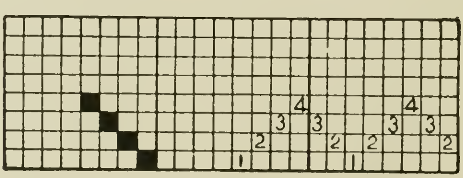


Fig. 172.

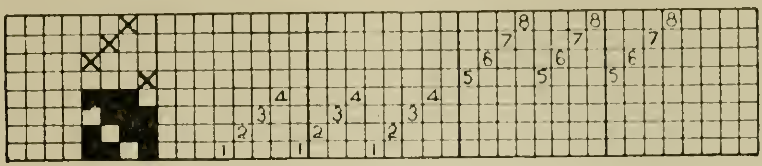


Fig. 173.

and bottom, it will be found that the raising marks of one division fall exactly on the sinking marks of the other compartment. This figure represents a perfect cut.

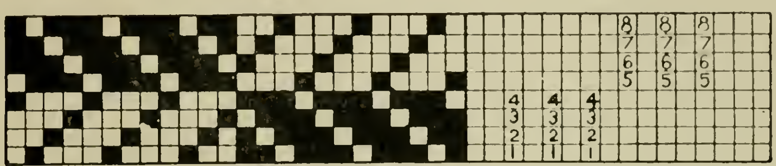


Fig. 174.

DIAPER WORK AND POINT DRAWS.

Damask. From what has been said in regard to fancy twills, and from examples that have been worked out, it will not be difficult to understand the drafting of the cloth known as Damask. Instead of straight-over drafts, damask designs are usually woven by means of what is termed a diamond draft; that is, a draft that runs from the front harness to the back harness and then returns to the front in the opposite order, thus forming a zigzag figure on the harness. Sometimes there are patterns of a more complex character woven on this system of drafting. This will be explained under the head of double, triple and alternate diamond drafts.

The length or number of picks in the repeat of the design is worked out on the same principle as the draft for the warp. (See

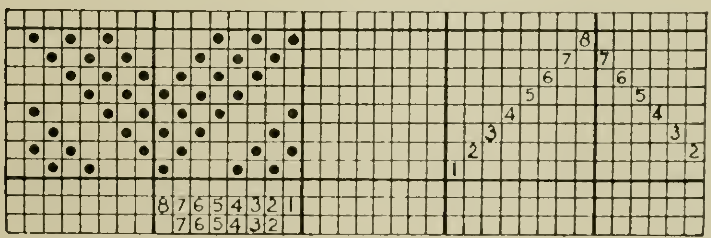


Fig. 175.

Fig. 175.) Whatever variety, therefore, is adopted for the groundwork or plan, according to the foregoing explanations, the result of the extended pattern will be nearly double the number of ends in the warp. The additional threads and formation of twill will be in direct opposition to the original ground plan. As the filling is also carried out on the same principle as the warp, the design is nearly doubled by the picks, the resulting design or twill being run in the opposite direction. Thus a square or diamond figure is commonly produced. It must be particularly noticed that there is only one thread drawn on the first and last harness, and that the filling returns on the same scheme, so the whole design will be nearly four times the original figure.

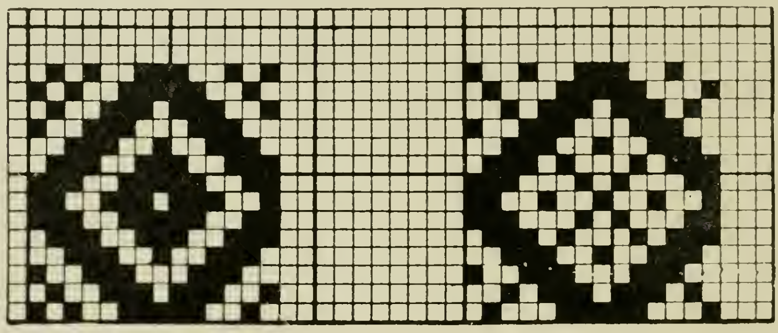


Fig. 176. Fig. 177.

The smaller weaves of this kind produce only a limited number of figures, generally a small diamond with a dot in the center, which gives the resemblance of an eye; hence this variety of design is called a bird's-eye. But when we use 8 harnesses or more, they admit of considerable diversity in flushing, twilling and the addition of plain texture, thus deviating from the formal

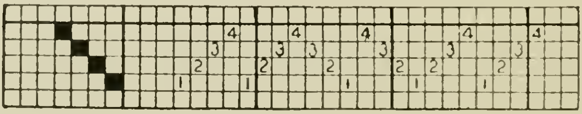


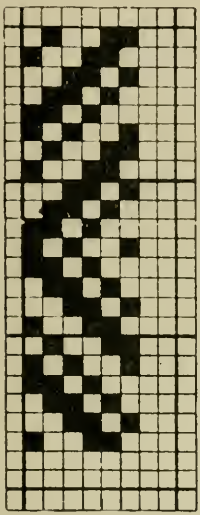
Fig. 178. DOUBLE DRAFT.

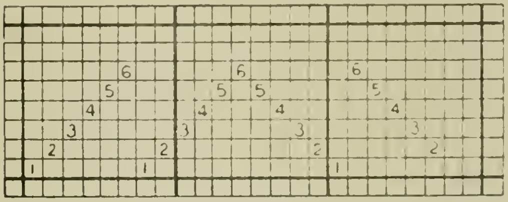
bird's-eye. The design now assumes the appearance of damask work.

Double Draft. These examples show what a great variety of figures can be woven on the damask work principle, especially

those of a large ground or original figure. All of these figures are produced by the extension of the diamond draft. As the resources of fancy weaving are inexhaustible, various other changes can be effected by merely diversifying the order or succession of the draft independently of the position of the filling.

As every extension of the draft in this manner enlarges the figure in a duplicate proportion, that is, as the square of the number of threads in one set of the draft, such patterns, when the harnesses are numerous, will occupy a considerable space on design paper. In all double drafts it should be understood that the filling or picks are extended in the same order as the warp draft.





DOUBLE DRAFT.

Fig. 179.

The double draft, Figs. 178 and 179, with any system that may be adopted, always produces two square or diamond effects. These are formed one within the other, and are again surrounded by others of the same character.

Triple Drafts. Fig. 180. A triple draft enlarges the dimensions of these patterns still further, producing three similar designs, one within the other. These figures are generally termed concentric designs. From this example it will appear that any number of concentric figures may be formed by repeating the draft any number of times straight over the harnesses in one direction, and by returning in the opposite direction an equal number of times.

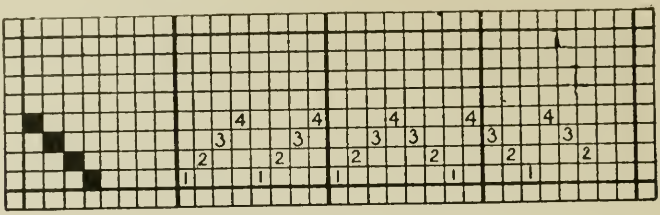


Fig. 180. TRIPLE DRAFT.

Alternate Drafts. Fig. 181. Another method of diversifying the drafts of lined work patterns is by dividing the harnesses into two sets. Take 10 harnesses, for example, which, when divided, should form 2 sets of 5 each. On either set we can make a diamond point, double or triple draft. This arrangement throws the group of small figures produced by each set of harnesses into alternate squares, somewhat resembling the draft-board pattern, each square again being composed of diaper or damask work. The

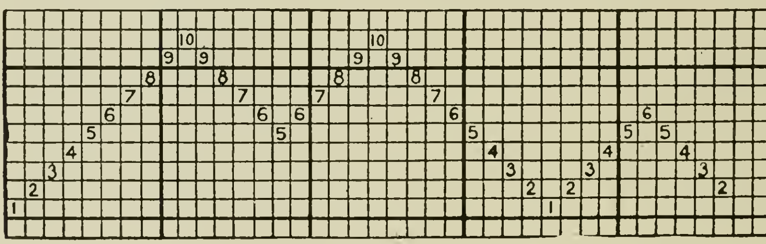


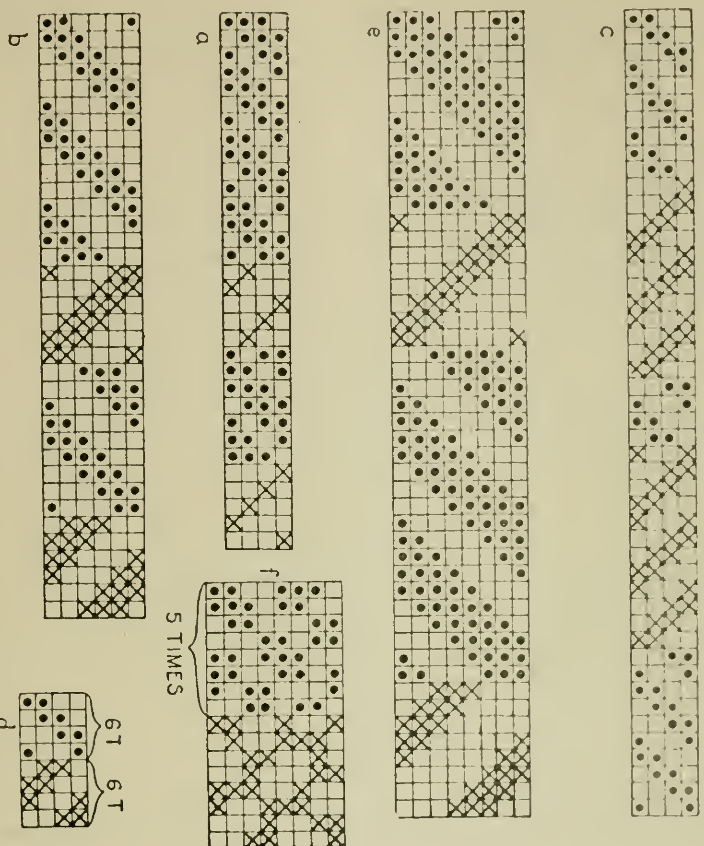
Fig. 181. ALTERNATE DRAFT.

following draft is an explanation in itself. To find the number of harnesses required for any lined work design, either from the fabric or design paper, count the threads from the center of one figure to the center of the surrounding figure. This will give the number of harnesses. If a square be formed of which this is a diagonal, and is repeated four times, but inverted so that any one corner of the design may be a common center, and allowing only one thread for each of the points, both by the warp and filling it will give one complete set of the design.

Damask work designs are used to considerable advantage in the linen trade, and also to some extent in cottons. This class of work makes good designs for the shawl trade, provided the warp is of one color and the filling of some darker shade of another color.

EXERCISES ON DAMASK PATTERNS.

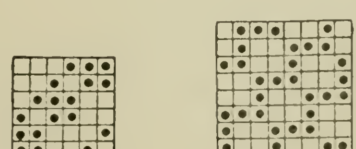
1. Form a check from the accompanying damask stripes *a*, *b*, *c*, *d*, *e*, *f*.



2. Make damask stripe designs on 48 ends from weaves *g* and *h*.

3. Make check designs from three stripes (Question 2).

4. Make two original damask stripe and corresponding check designs.



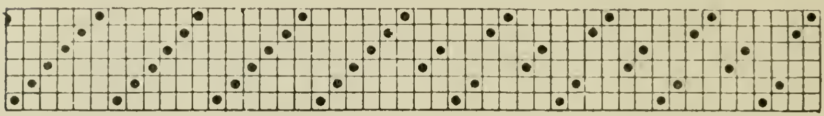
g h

EXERCISES FOR PRACTICE.

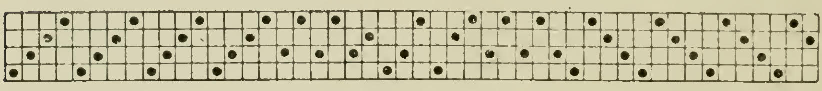
1. Work out the designs from the following drafts and chain plans.

2. Work out the designs obtained by using chain plan M with drafts G, H, K, L.

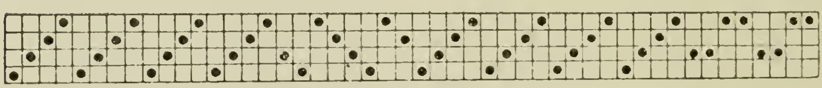
3. As No. 2, but with chain plan N.



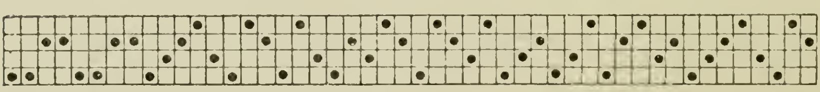
A



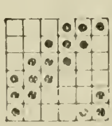
B



C

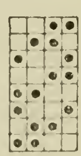


D



A

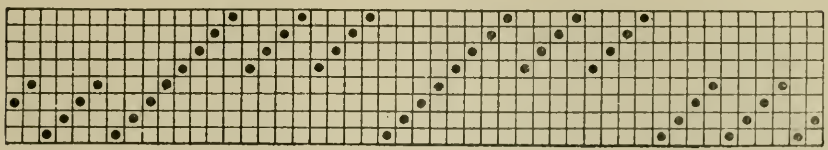
B



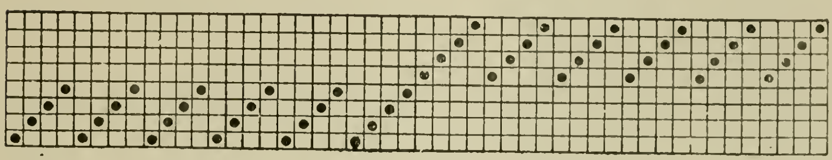
C

D

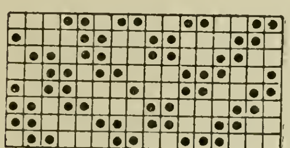
(Continued on next page.)



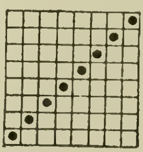
L



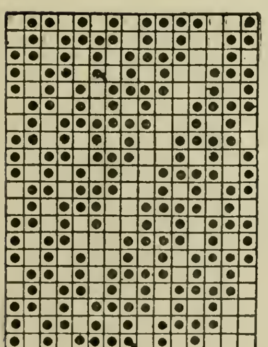
K



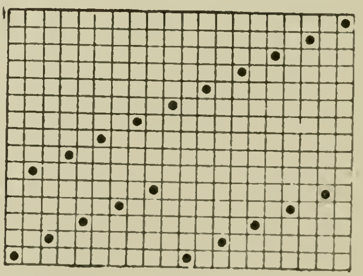
E



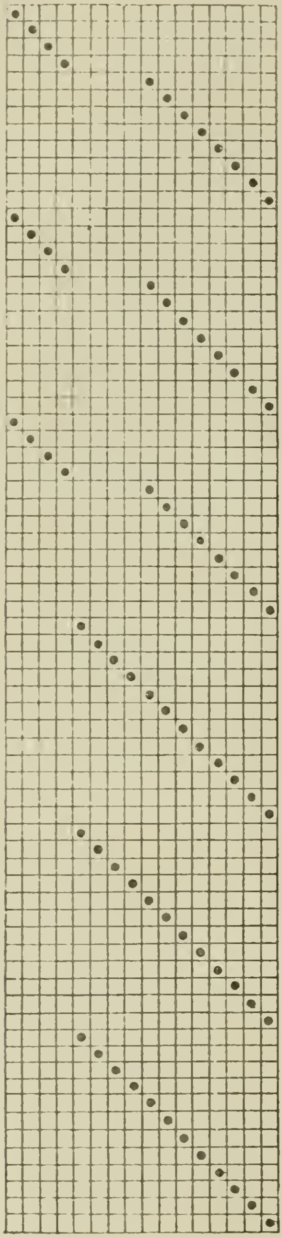
G



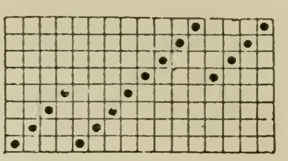
F



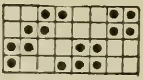
F



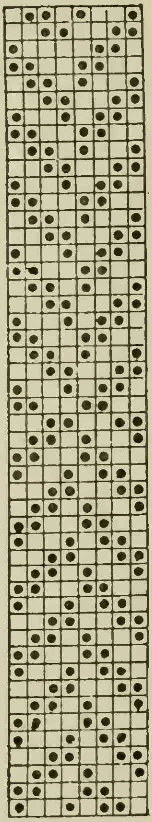
E



H



M



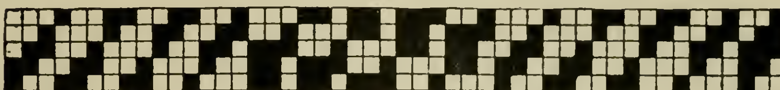
N

EXERCISES IN DRAFTING.

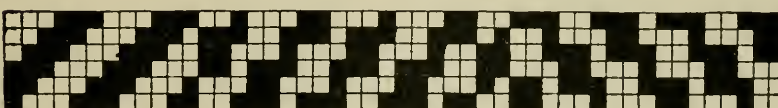
Reduce each of the following designs to weave on the fewest possible number of shafts, giving draft and chain.

1

2



4



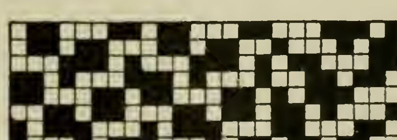
6

7

3

5

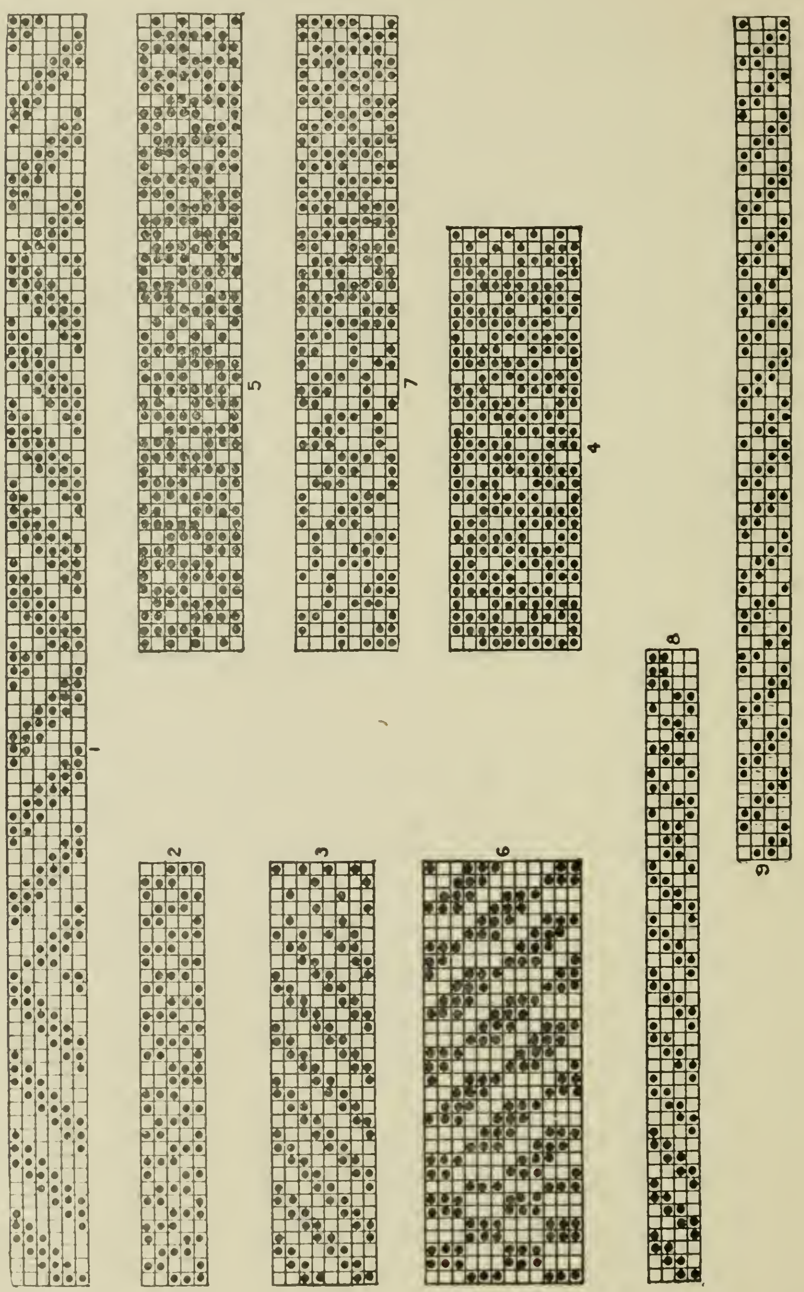
8



9

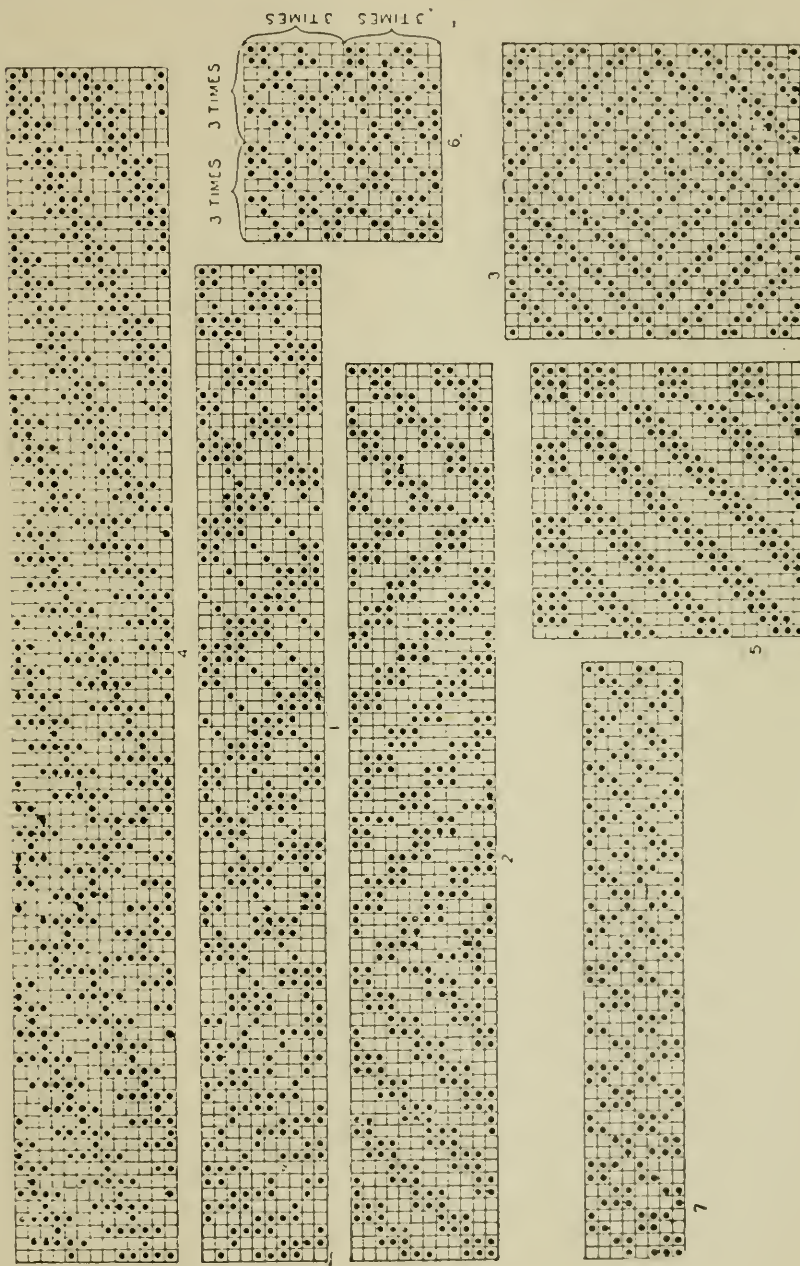
EXERCISES FOR PRACTICE.

Draft each of the following designs on fewest possible shafts and give chain.



EXERCISES FOR PRACTICE.

Make draft and chain plan for each of the following designs, giving good workable drafts.

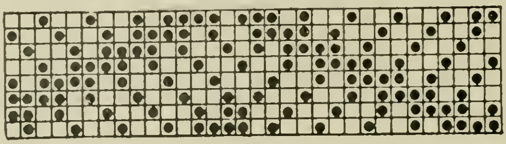


EXERCISES FOR PRACTICE.

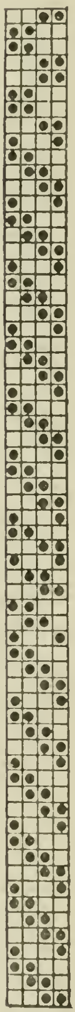
1. Make good working drafts and chain plans for designs A and B and supply chain plans for two original designs to weave in the same draft.

2. Make one draft to work the two accompanying designs C and D and give the chain plan for each.

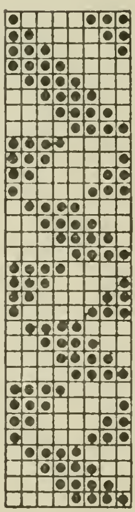
3. Run out the accompanying design E until complete, then draft on 28 shafts and give chain plan.



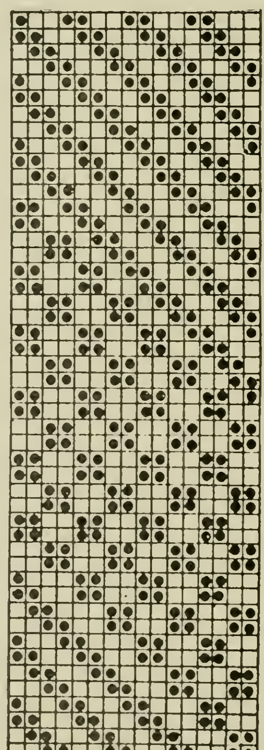
A



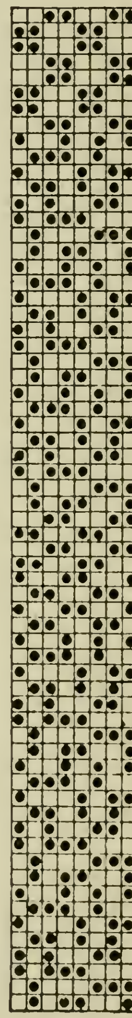
C



B



E

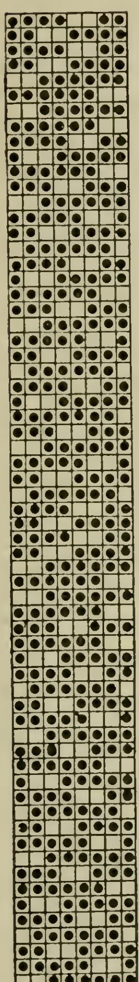


D

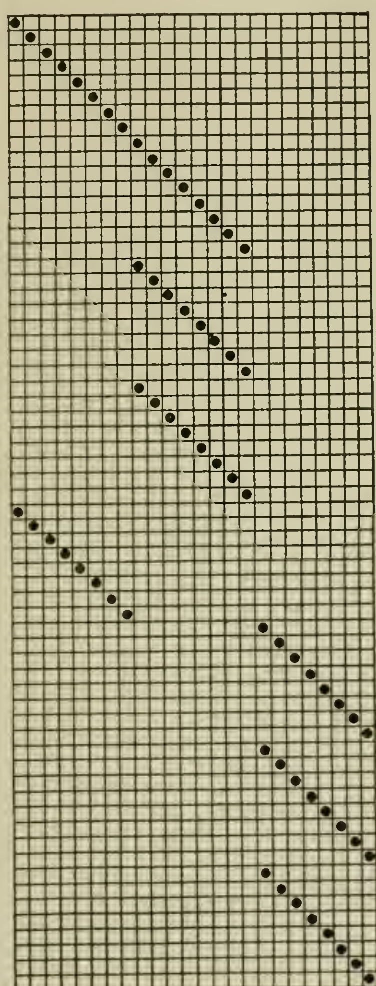
4. Give draft and chain plan to weave design F on the fewest possible shafts; also give chain plan to weave it with draft G.

5. Give two original designs and chain plans to weave with draft G.

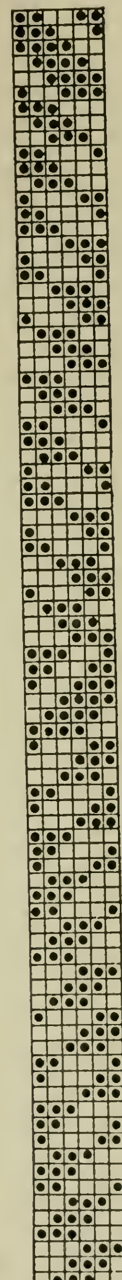
6. Give chain plan to weave design H with draft G.



F



G



B

REEDS AND SETT.

This is a section of the designing department in which great diversity of opinion prevails as to the manner of application, and also in what is represented by the terms reed and sett. Reeds are a series of narrow strips of metal between which the threads of the warp pass in the loom, the purpose of the reed is twofold — to keep the threads evenly divided and to strike the filling at varied intervals and places to beat it up into the position it has to take in the cloth. The derivation of the name is from the material used many years ago to form the narrow strips which divide the spaces, splits, split reed, or dent. The origin of the word split, for dent, is also explained by this allusion to the original material used for reed-making

The coarser the reed, to a certain extent, the easier the picks go into the fabric. The finer the reed the smoother the goods, and with a perfect reed there will be fewer reed marks.

Reeds may be unevenly set, the wires may not stand parallel with the warp, the wire may be too thick, thin, wide or narrow for the work on hand; indeed, a perfect reed is not so easily found as needed. The threads in each dent should be such as to be the same in each repeat of the pattern.

Threads running over each other may often be remedied by a different number of threads per dent, or by taking different threads of the pattern in the same dent. Some patterns look best with all the threads of the same texture together in the same dents; others are improved by a different division.

Reeds are damaged more by careless handling and abuse than by actual wear and tear necessary. Flat steel wire is now considered the best material for reeds, brass and iron are too soft, and once bent do not spring back into shape or place.

The term sett denotes the number of threads of warp contained in a certain space, while the reed marks certain divisions of those threads in that space. In some districts the reed is denoted by so many dents on so many inches, as example: 1050 dents on 35 inches. In other districts the reed is known by dents on the ¼ yard or nine inches, as example: 270 reed, which means 270 dents on 9 inches. The best plan for denoting the reed is to take one inch as the space for measurement and the number of dents contained in that space forms the base of the reed. Example: No. 10 reed requires 10 dents, splits or spaces in one inch.

When the threads per inch are of an equal number the reed for the division is easily found, that is for ordinary requirements. For example: say 40 threads per inch, then a 20 reed two in a dent, or a ten reed four in a dent, may be employed; that is, a reed having 20 dents or 10 dents per inch, and each dent dividing two or four threads respectively. By this method the number of warp threads for the whole chain or warp is easily ascertained.

Supposing that the warp is required 70 inches wide at 40 threads per inch, then $70 \times 40 = 2800$ threads in the warp are given, and so with any other number of reed. The preferable plan of obtaining the reed under any circumstances is to divide the total number of threads intended for the warp by the number of inches it is to occupy in the reed, which gives the number of threads per inch. This does not, however, dispense with the fractional part of a thread for one inch in all cases, and the necessity for a fractional reed to meet it, but it has the merit of simplicity, as assisting in the matter of calculation. Suppose we require 42 threads per inch and had been using a 21 reed two in a dent, but found the reed too fine, what reed could we use to put four threads in a dent—$42 \div 4 = 10\frac{1}{2}$ reed? The only way to obtain an even number of threads per inch is to construct the design accordingly, and apportion the number of threads in the warp so that their division by the number of inches occupied in the reed will give it, whether 2, 3, 4 or more threads are intended for each division of the reed.

As a rule two threads are reckoned for each division, but the requirements of design and the construction of cloth are so various in the sizes and counts of yarn, and the number of threads per inch employed in the warp, that the number of dents per inch of the reed is dependent upon it. But the number of threads in the division of the reed is not always uniform—that is, not always the same in each reed throughout the whole width of the warp. That depends upon the pattern to be woven. For example, in the production of a stripe, while two threads in each dent may be required, say for three-quarters of an inch space, the succeeding dents may require 3, 4, 5, or 6 threads in them, and then repeat with the two threads, and so on throughout the width of the reed. This will show that no hard-and-fast rule can be laid down which will give universal direction—or suit all the cases which may arise according to the caprice of design.

Given the number of threads which constitutes the warp, and the number of inches in the width those threads are to be distributed over, measured on the reed with the number of threads for each dent or division of the reed, a foundation is obtained upon which the whole matter rests. The shrinkage of the goods in weaving must always be borne in mind, and included in estimates, allowances for take-up of yarn in weaving must be taken into account. Arbitrary rules in relation to these allowances are of little use, there is much variation in different mills and under different circumstances. The convenience of minute records on such subjects is apparent.

Reed Calculations.

Example No. 1.—*Find the width.* The threads in the warp and threads per inch being known, find the width by dividing the total number of threads in the warp by the threads per inch.

2400 x 50 = 48 inches wide.

Example No. 2.—*Find the reed and threads per inch.* The threads in the warp and width being known, find the threads per inch or reed one thread in a dent by dividing the threads in warp by the width in inches.

2400 ÷ 48 = 50 threads per inch. 50 ÷ 5 in dent = 10 reed.
50 ÷ 4 in dent = 12½ reed. 50 ÷ 2 in dent = 25 reed.

Example No. 3.—*Find the number of threads in warp.* The threads per inch or reed being known, also the width in reed, find the number of threads in warp by multiplying the threads per inch by the width in reed. 50 x 48 = 2400 threads.

Example No. 4.—*Irregular reeding.* When the threads in a dent are irregular, find the average number of threads per dent and inch, by dividing the number of threads in a pattern by the dents occupied by the pattern and multiplying by the reed.

What are the threads per inch when the warp is reeded as follows:—1 dent 2 threads, 1 dent 4 threads, 1 dent 4 threads, 1 dent 2 threads, and 1 dent 3 threads, 15 threads in 5 dents? Use a 15 dent reed.

15 ÷ 5 = 3 threads per dent average. 15 dent x 3 = 45 threads per inch.

LECTURE No. 1.

COLOR AS APPLIED TO TEXTURE.

Primary, Secondary, and Tertiary.

In many fabrics the colors are quite as important as the texture. The designer should therefore acquire a thorough knowledge of the laws which govern color harmony. This can be done only when the nature of colors is thoroughly understood.

The science of color teaches the nature and causes of colors, their distinctions, their relations to each other, their classification, the mental effects that attend them, and the causes and laws of harmony. It also includes the modifications of colors arising from varying sensibility of the eye, and the peculiarities of color vision which are found to exist in different individuals.

The science of color is very extensive, and the space at my disposal will only permit me to treat of it briefly.

The harmony of colors, the influence of one color over another when placed in close proximity, are subjects which can only be understood after much study.

There are few objects to which color may not be applied, and many articles which are now colorless might be colored with advantage.

Our reasons for applying color to objects are twofold, which emphasize its true use.

First, color properly applied lends to objects a new charm, a charm they would not possess without it; and, secondly, color assists in the separation of objects, or parts of objects, and thus making them more distinctive and giving assistance to their form.

While it is true color bestows on objects a charm such as they would not have in its absence, and which in the hands of men of experience and knowledge make objects lovable, it must be remembered that the mere application of color will not do this. Color, indeed, may be so applied to objects as to render them infinitely more ugly than they were without it. Knowledge, when correctly applied, will enable us to transmute base materials into works of marvelous beauty, ingenuity, and very valuable.

Knowledge of the laws of art, then, is the true philosopher's stone, for we may also say when it is possessed by the artist he is enabled to transmute the baser metals into works of art, or we may say gold.

But a little knowledge will not do this. In order that we produce true beauty we require much knowledge, and this can only be obtained by diligence, and surely the end to be gained is worth plodding and toiling for. *The Second* object of color is that of assisting in the separation of form. If objects are placed near to one another, and are all of the same color, the beholder will have more difficulty in seeing the boundaries or terminations of each than he would were they variously colored, he would have to come near to them in order to see their limits. Thus color assists in the separation of form.

This quality which color has of separating forms is often lost sight of, causing considerable trouble in textile manufacture. The designer must not lose sight of the fact that color is the means by which we render form apparent. Colors, when placed together, can only please and satisfy the educated when combined harmoniously, or according to the laws of harmony. What, then, are the laws which govern the arrangement of color, and how are they applied?

I shall endeavor to answer these questions by making a series of statements in axiomatic form, and then enlarge upon them.

1. Regarded from an art point of view there are but three colors—blue, red, and yellow.

2. Blue, red, and yellow have been termed primary colors, as they cannot be formed by the admixture of any other colors.

3. All colors other than blue, red, and yellow result from the admixture of the primary colors.

4. By the admixture of blue and red, violet is formed.
   ,, ,, ,, ,, red and yellow, orange.
   ,, ,, ,, ,, yellow and blue, green.

5. Colors resulting from the admixture of two primary colors are termed secondary, hence violet, orange and green are secondary colors.

6. By the admixture of two secondary colors a tertiary color is formed. Thus violet and orange produce russet, the red tertiary; green and violet produce olive, the blue tertiary. Russet, citrine, and olive *are the three tertiary colors.*

7. When a light color is juxtaposed to a dark color the light color appears redder than it actually is, and the green greener, and when blue and black are juxtaposed the blue manifests but little alteration, while the black assumes an orange tint or becomes "rusty."

9. No one color can be viewed by the eye without another being created. Thus, if red is viewed the eye creates for itself green, and this green is cast upon whatever is near. If it is green that is seen, red is in like manner created and cast upon adjacent objects; that is, if red and green are juxtaposed each creates the other in the eye, and the red created by the green is cast upon the red, and the green created by the red is cast upon the green. This explains the reason why the red and green appear brighter by being juxtaposed. The eye also demands the presence of the three primary colors, either in their purity or in combination, and if these are not present, whatever is deficient will be created in the eye, and this induced color will be cast upon whatever is near. Thus, when we view blue, orange, its complimentary color, which is a mixture of red and yellow, is created in the eye, and this orange color is cast upon whatever is near. If black is in juxtaposition with the blue, this color (orange) is cast upon it, and gives to it an orange tint, thus causing it to look "rusty."

10. In like manner, if we look upon red, green is formed in the eye, and is cast upon adjacent colors; or, if we look upon yellow, violet is formed.

11. Harmony results from an agreeable contrast.

12. Colors which perfectly harmonize improve one another, and are seen in perfection.

13. In order to perfect harmony the three colors are necessary, either in their purity or in combination.

14. Red and green combine to yield a harmony. Red is a primary color, and green, which is a secondary color, consists of yellow and blue, the other two primary colors. Blue and orange also produce a harmony, the red and yellow primary colors being present, and yellow and violet produce a harmony, the blue and red primary colors being present.

15. The primary colors in perfect harmony produce exact harmonies in the proportions of 8 parts of blue, 5 of red, and 3 of yellow. The secondary colors harmonize in the proportions of 13 of violet, 11 of green, and 8 of orange. The tertiary colors harmonize in the proportions of olive 24, russet 21, and citrine 19.

16. There are, however, subtleties of harmony which are difficult to understand.

17. The rarest harmonies frequently lie close on the verge of discord.

18. Harmony of color is in many respects analogous to harmony of musical sounds.

19. Qualities of colors. Blue is a cold color, and appears to recede from the eye.

20. Red is a warm color, is exciting, and remains stationary as to distance.

21. Yellow is the color most nearly allied to light. It appears to advance toward the spectator.

22. At *twilight* blue appears much lighter than it is, red much darker, and yellow slightly darker. By ordinary gaslight blue becomes darker, red brighter, and yellow lighter. By this artificial light a pure yellow appears lighter than white, when viewed in contrast with certain other colors. By electric light assume twilight.

23. By certain combinations color may make gladness or depression, and in certain combinations may affect the mind as music does.

24. Teachings of experience. When a color is placed on a gold ground it should be outlined with a darker shade of its own color.

25. When a gold ornament falls on a colored ground it should be outlined with black.

26. When an ornament falls on a ground which is in direct harmony with it, it must be outlined with a lighter tint of its own color. Thus, when a red ornament falls on a green ground it should be outlined with lighter red.

27. When the ornament and the ground are in two tints of the same color, if the ornament is darker than the ground it will require outlining with a still darker tint of the same color, but if lighter than the ground no outline will be required.

28. The surest and readiest method of acquiring a practical knowledge of colors and their effects in textile fabrics is to analyze a large collection of samples.

Fashion controls the designer to a great extent, and fashion moves in cycles.

Exhaustive collections of the most fashionable colors and combinations of each season, with a proper record of particulars, will not only add to one's stock of knowledge, but anyone who is at all observant will after a while be enabled to anticipate coming demands of fashions with considerable accuracy.

The value of this ability needs no comments. Every designer has suffered more or less from a lack of it, both in himself and in those who assume the control of the patterns in the market.

LECTURE No. 2.

COLOR OF THE SPECTRUM.

Treated scientifically, the six colors of the spectrum are taken as colors, and all variations in tints, shades and hues are considered modifications of these six colors: Red, Orange, Yellow, Green, Blue, Violet.

These are referred to by different writers as standard spectral, positive, pure, full and saturated colors. The name normal is generally accepted as it expresses the natural condition of color when affected by light.

A standard color, or a positive may be a brown, straw, or even a gray, which is composed of black and white or any other color which is accepted as the typical color of a series.

Tone covers the entire scale of color, from the darkest shade to the lightest tint. So in a perfect scale of tones, the grading from one shade or from one tint to another would be so slight as to be almost imperceptible, and would end in white in one direction and in black in the other.

Tones are produced by adding white or black to the normal color.

Tint is a tone of a color lighter than the normal. A tint is produced by adding white to the normal color.

Shade is a tone of a color darker than the normal. A shade is produced by adding black to the normal color.

Tints are lighter, shades are darker than the normal color. Tints and shades constitute the whole range of tones.

Hue. This term is applied to a color when the normal color has been modified or changed by the addition of another normal color. Thus, if a small portion of blue is added to red or mixed with it, we should have a blue red, which is a hue of red; if a little green is added to blue, the result would be a green blue. The last name indicates the normal color in the scale and the first name is the color added.

Broken colors are the normal colors dulled more or less by the addition of a gray.

Value is the luminous intensity of a color tone or hue, as it stands in relation to other colors, tones or hues.

Unit of color. In colored work the basis of comparison is generally white. (Many artists, when sketching, put a slip of white paper upon some object in the foreground, as a basis of

comparison in determining the tones and hues of the various colors in the scene they may be painting.) In textile designing, the basis of comparison is a bleached white.

Keeping the values of the composition, means having a harmonious balance of tone or intensity of the different colors used, so that the combined effect will not be injured by an excess of any particular color. Take, for example, a light blue and a pink will combine and harmonize, as far as values are concerned. Pink is a red tint, but an equal quantity of light blue and a normal red would not harmonize in value because the greater intensity of the red would overpower the light blue. When the intensities differ, the quantities must also differ.

It is very seldom that equal quantities of two or more colors can be used in a combination, when we desire to produce a harmonious effect.

Potentiality is the power of a tone, hue or color to affect other tones, hues or colors, when associated with them. The potentiality or combining influence of the six normal colors, is yellow, orange, red, green, blue, violet.

Scaling is the arrangement of colors in the order of their intensity. Scaling may be by tones, hues and colors, or by these combined. The scale of the normal colors consists of their regular spectrum arrangement: Red, orange, yellow, green, blue, violet. A scale of tones would be, lighter blue, light blue, blue, dark blue, and darker blue.

The term tone covers all the variations of a color that can be produced by adding black or white to the normal color, but only one of these may be added, otherwise it becomes a broken color.

A scale of hues consists of a normal color and its hues, violet red, red, orange red. This is called scale of hues of red.

Luminous colors are those that reflect light in large quantities. These are yellow, orange, red and green. Yellow is the most luminous of the colors.

Warm colors. Red, orange and yellow, and the hues in which they predominate, are called warm colors. Orange is the warmest of these colors.

Green, blue, and pale violet, and the hues in which they predominate, are called cool colors.

LECTURE No. 3.

NEUTRAL COLORS.

The effect of these tints and colors is most important. Suppose we have alternate stripes of red and green, or if we have red figures on a green ground, or vice versa, the eye could not rest long upon them without experiencing an unpleasant sensation; the two colors would begin to swim (blur into each other, as it were,) and the longer the eye rests upon them the stronger and more unpleasant will this blurring sensation become, but if the two colors be separated by black or white, or some tertiary or neutral oolor, then this blurring sensation will be entirely prevented, and yet perfect harmony will result.

In the same manner, if blue and orange be laid side by side, the blurring sensation will result, but it may again be prevented by the introduction of neutral colors. If violet and yellow are placed together the effect is not quite so unpleasant, because the two colors, although complimentary colors, are more nearly allied to darkness and light respectively.

Yet even in this case the effect is much improved by the presence of tertiary or neutral colors. Therefore, at all times, colors which are complimentary to each other, should either be present in subdued form or separated from each other by the presence of a neutral color.

In addition to this quality of modifying the effect of complimentary colors, neutral colors also possess the property of modifying the effect upon other colors possessing the same common element. As has been shown, colors placed side by side have the effect of detracting from each other, but if separated by black or white, or by neutral colors, this mutual detraction is prevented or modified. If, for example, we place blue and green together, one color will partly destroy the other, and the point of junction of the two will scarcely be discernable; but if we separate the two by either a black or white line, the effect is materially improved. In the same manner we may deal with red and orange, or with any other two powerful or bright colors, and the result will be invariably the same.

In speaking of neutral colors the peculiar properties of gold should be pointed out.

Although the appearance of gold is decidedly yellow, yet it is one of the most neutral colors. Not only does it harmonize

with any or all colors, but it modifies the effect of any two colors, or composition of color upon each other. It is for this property as much as for richness that gilded frames are preferred for pictures, the richness and neutrality of gold not only tending to improve the effect of the coloring of the picture, but at the same time effectually preventing the interference of any surrounding colors.

Gold is a color which is very rarely used in textile fabrics, yet it may sometimes be used with advantage, bearing in mind this peculiar property.

LECTURE No. 4.

COMBINATION OF COLORS.

Red and blue, in small quantities, is a useful combination, but if used in large quantities is considered bad taste and inelegant. The red assumes a bluish cast, or what is termed crimson. The blue takes upon itself a greenish cast..

Red and yellow. This combination is bright and cheerful, but very powerful; be careful in using this combination. The red appears scarlet, the yellow assumes a greenish cast.

Yellow and blue. Each color increases in luminosity, lustre, and depth. Yellow and blue being contrasting colors, they do not suffer much change in hue by association, one color in such combinations gives precision to the qualities of the other.

Red and green. Red appears exceedingly bright and cheerful, the lustre and fullness of hue is emphasized. The green appears softer and cooler, that is, the coolness and softness of hue is emphasized. Red and green are complimentary colors; they also give precision to the qualities of the other.

Red and violet. Red becomes more scarlet, and takes upon itself a yellowish cast. The violet becomes greenish; this combination is not good, but very inelegant.

Red and orange is a very warm and powerful blend; great care should be used with this combination. The red becomes more violet, the orange becomes yellowish.

Yellow and violet. This is a most beautiful combination, warm and potent. Both colors gain in lustre or luminosity and strength. This is a perfect or complete contrast.

Blue and orange. Both hues are increased by association. Recommend caution in using this blend.

Orange and green. This is a very strong contrast; orange appears scarlet, and the green somewhat of a violet cast.

Violet and green. This is not a very pleasing combination, although much used. The violet assumes a reddish cast, while the green appears of a yellowish cast and much flatter in tone.

Violet and orange. This is always considered a very elegant and effective combination. The violet is slightly greener, and the orange becomes more luminous or yellowish.

LECTURE No. 5.

REVIEW OF COLORS.

Definition.

Color is a visual sensation, caused by waves of incomplete light acting upon the eye.

Prismatic colors, white light, that is sunlight, is composed of various colors, as is easily shown by placing a prism in the path of a small beam of sunlight. The prism separates the different colors that compose white light, and produces what is known as the prismatic or solar spectrum, the colors of which we have placed under the head of normal colors. Red, orange, yellow, green, blue and violet, these colors are the same and their arrangement is in the same order as in the rainbow. The three primary colors are red, blue, and yellow. The secondary colors are produced by the admixture of two primaries. The admixture of the secondary colors produce the three tertiaries.

Red and Blue	Produce	Violet
Red and Yellow	,,	Orange
Blue and Yellow	,,	Green
Orange and Green	,,	Citrine
Violet and Green	,,	Olive
Orange and Violet	,,	Russet

REVIEW OF COLORS.

Red, when placed in juxtaposition with green, increases its intensity, green also increases the intensity of red. Normal red differs very little from that of a ripe red cherry.

Orange, next to red, is one of the most pleasing colors, its complimentary color is a greenish blue.

Yellow in the decorative arts is almost always represented by gold. In moresque art, where yellow is used extensively, gold is almost always employed instead of the yellow pigment, the complimentary color to yellow is violet blue.

Green. During part of the year green is the most prevalent color in nature, and it is much more pleasing in nature than it is in art and dress. Many of the so-called greens in nature, however, incline more towards yellow than green, and experiments in out of door sketching soon convinces the painter that things are not as green as they seem. For general use the subdued greens, those approaching the grays and yellows, are more satisfactory than the brighter ones.

Green is the complimentary color of red, blue is classed as a restful color, also a receding and a cool color. It is unobtrusive wherever used. Light blue resembles white, dark blue has the reverse effect and approaches black more nearly than any other color. The complimentary color is orange.

Violet. This color varies little from purple, being but slightly bluer in hue. In pigmentary colors it is produced by mixing red and blue. Violet is a color that is more easily managed in combination than some of the other colors, and is very often used in dress when subdued in tone and hue. Combinations which are considered allowable: Violet and yellow green, violet and orange yellow, violet, orange and green, violet, gold and gray. Violet also harmonizes with several other colors when more than two enter into the combination. Violet does not combine with red and purple, blue and violet is a bad combination.

Light red is any tone of red that is lighter than the normal color. Complimentary color of red is blue green, so a tint of blue green will harmonize with light red.

Light orange is one of the common colors in nature, the sky is often streaked with it in the morning, and tinted with it in the evening.

Light yellow is any tint of yellow that is lighter than the normal color. The most beautiful tints of yellow may be seen in the sky at sunrise and sunset.

Light green. Nature furnishes a great variety of greens, most of them, however, are lighter than the normal green, and incline towards yellow in hue. The most valuable office of

green is to give brilliancy to a design. It combines well with gold, but is seldom agreeable when used in combination with several different colors. A light green pattern upon a dark ground will be found pleasing in effect, the reverse arrangement is not satisfactory. Green is a color that is difficult to handle in large masses, and it needs other colors to assist in producing a harmonious effect. A light green, or grayish green, however, usually looks better in large masses if used alone, or with simply a stripe or border of a darker tone of the same color. A subdued green fatigues the eye the least of any of the colors.

Light blue is a restful and retiring color, it has the effect of making objects appear more distinct than they are, this is why it enters largely into the decoration of ceilings and small rooms, it is one of the cool colors which puts it in demand for summer draperies.

White forms an agreeable harmony with blue, without the assistance of other colors. The tints of blue and those that incline towards light gray in tone are very pleasing.

Light violet. Violet is a variety of purple, it is said to be a red graduated with blue, while in violet the red and blue are equally blended.

Dark red. The variations of a color that are produced by adding red or black to the pure color are its different tones. Dark red is a tone of red that is darker than the normal red. There is no limit where a darkened color ceases to be the shade of that color until the effect of the color is entirely lost and black is reached.

Dark orange that inclines towards red is called a deep orange or red orange, but when it is simply darkened either by the absence of light or by the addition of black, it is a shade of orange, in its darker shades it forms a pleasing combination with the hues of subdued yellow, especially when a stripe or small figures of black forms part of the design.

Dark yellow. Comparing it with other yellows it will be found less luminous than the normal yellow, and not so red in hue as the normal orange.

Red orange is nearly the color of scarlet. Among the many pleasing combinations of color met with in designs: Red and orange, blue and gold, red orange pattern upon a light orange yellow ground enlivened with a light blue sparingly used.

Green yellow. This is a hue of yellow, being produced in the pigmentary colors by the addition of a little green to yellow. It is one of the retiring restful colors, and for that reason it forms an excellent background in decoration to bring out the effects of orange, red and violet, of which it is the opposite.

Yellow green is the chief color of nature in early spring. In autumn the greens that were so intense in summer, are again subdued with yellow. Although yellow green is a strong color, it has been used more successfully and more generally than pure green.

Green blue is not a very common color, it is, however, used in decoration and dress goods to quite an extent, especially when it is subdued by association with some other color.

Tone is the intensity of a color or hue. It may be of any intensity between white and black.

A tint is a tone of a color that is lighter than its normal or standard tone.

A shade of a color is a tone that is darker than its normal or standard tone.

The tints and shades of the light or prismatic theory are produced by increased or diminished illumination.

The tints and shades of the pigmentary colors are produced by the addition of white or black to the normal colors.

LECTURE No. 6.

ANALYTICAL TABLE OF COLORS.

It has been found that the primary colors in perfect purity produce exact harmonies in the proportion of 8 parts of blue, 5 parts of red, and 3 parts of yellow. That the secondary colors harmonize in the proportions of 13 violet, 11 green, and 8 orange, and that the tertiary colors harmonize in the proportions of 24 olive, 21 russet, and 19 citrine.

The figures which follow the colors represent the proportions in which they harmonize.

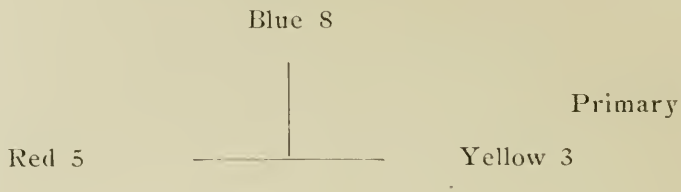
Primary—Blue 8. red 5, yellow 3.

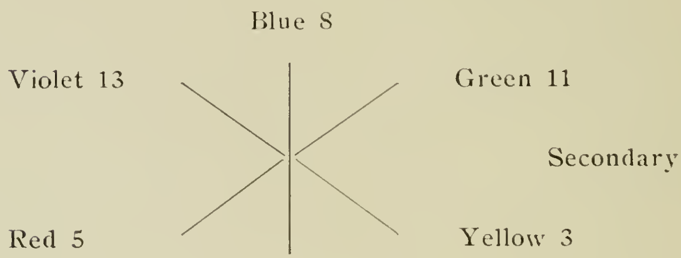
Secondary—Violet 13, green 11, orange 8.

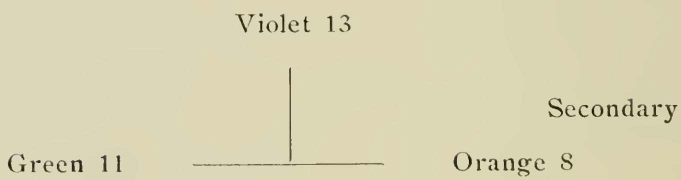
Tertiary—Olive 24, russet 21, citrine 19.

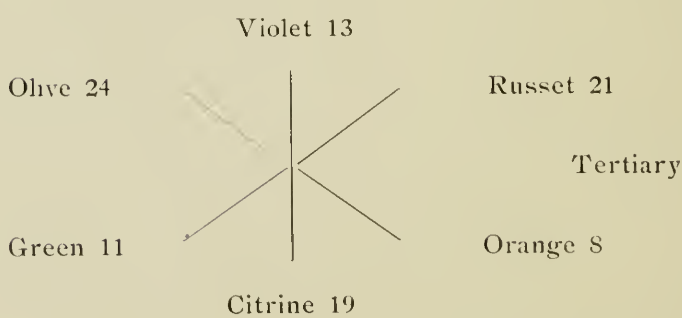
PRIMARY.		SECONDARY.		TERTIARY.
Red	5	Orange	8	Citrine or yellow tertiary, 19.
Yellow	3			
Blue	8	Green	11	
Yellow	3			
Blue	8	Violet	13	Russet, or red tertiary, 21.
Red	5			
Red	5	Orange	8	
Yellow	3			
Yellow	3	Green	11	Olive, or blue tertiary, 24.
Blue	8			
Blue	8	Violet	13	
Red	5			

DIAGRAMS OF HARMONY.









When two colors are to produce a harmony, the one will be a primary color, and the other a secondary formed of the other two primaries (as noted in our first lecture, the presence of the three primary colors is necessary to a harmony), or the one will be a secondary color and the other a tertiary color formed of the two remaining secondary colors.

PRIMARY.		SECONDARY.		
Red	harmonizes with	Green	—composed of	Blue and yellow
Yellow	,, ,,	Violet	,, ,,	Blue ,, red
Blue	,, ,,	Orange	,, ,,	Red ,, yellow

SECONDARY.		TERTIARY.		
Purple Blue and red	,, ,,	Citrine	,, ,,	Green and orange Yellow ,, yellow Blue ,, red
Green Blue & yellow	,, ,,	Russet	,, ,,	Violet and orange Red blue ,, red yellow
Orange Red & yellow	,, ,,	Olive	,, ,,	Violet and green Red ,, yellow Blue ,, blue

PROBLEM 1.

Block or checker board effect. 16 threads x 16 picks.

Section A. 8 threads 8 picks A1.
8 ,, 8 ,, A1. Commence with the 2d thread of this weave.
—
16

Section B. 8 ,, 8 ,, A1. Commence with the 2d thread.
8 ,, 8 ,, A1.
—
16

NOTE. Mark the weave A1, commencing with the 2d thread, with red.

Scheme or arrangement of warp. 1 thread dark color, 1 thread light color.

Scheme or arrangement of filling. 1 pick dark color, 1 pick light color.

PROBLEM 2.

Stripe for Woolen, Worsted, or Cotton. 24 threads x 12 picks.

Section A. 6 threads 12 picks B1.
B. 3 ,, 12 ,, B2.
C. 6 ,, 12 ,, B1.
D. 3 ,, 12 ,, B2.
E. 6 ,, 12 ,, B1.

NOTE. Mark the weave B2 with red.

Arrangement of warp. 2 lavender, 1 black and orange, 1 black and green, 2 lavender, 3 slate, 6 lavender, 3 slate, 2 lavender, 1 black and green, 1 black and orange, 2 lavender.

Arrangement of filling. All black, or dark color.

PROBLEM 3.

Stripe for Woolen, Worsted, or Cotton. 24 threads, 8 picks.

Section A. 8 threads 8 picks C1.
B. 4 ,, 8 ,, C3. Commence with the 3d thread and twill to left.
C. 4 ,, 8 ,, C1.
D. 4 ,, 8 ,, C3. Commence with the 3d thread and twill to left.
E. 4 ,, 8 ,, C1.

NOTE. Mark weave 3C with red.

Arrangement of warp. 4 drab, 2 brown, 2 drab, 2 brown, 2 drab, 4 brown, 4 drab, 4 brown. Filling, all brown.

PROBLEM 4.

Check for Woolen or Worsted. 40 threads x 40 picks.

Section A. 20 threads 20 picks D9. Commence with the 5th pick.
20 ,, 20 ,, D8.
—
40

B. 20 ,, 40 ,, D9. Commence with the 5th pick.

NOTE. Mark D9 with red.

Warp, all olive. Filling, all dark brown.

PROBLEM 5.

Fancy weave stripe trousering. 48 threads x 18 picks.

Section A. 48 threads 18 picks E113. Commence with the 5th thread and twill to the left.
B. 48 ,, 18 ,, E6.

NOTE. Mark E6 with red.

Arrangement of warp. 1 brown, 22 drab, 2 brown, 22 drab, 1 brown.
Filling. All brown.

PROBLEM 6.

Stripe for Woolen, Worsted, and Cotton. 24 threads x 12 picks.

Section A.	12 threads	12 picks	B1.	
B.	6 ,,	6 ,,	B2.	
	6 ,,	6 ,,	B1.	Twill to left.
C.	6 ,,	6 ,,	B1.	
	6 ,,	6 ,,	B2.	

NOTE. Mark B2 red. Mark 6th and 7th threads blue.

Arrangement of warp. 5 threads slate, 1 thread black and scarlet twist, 1 thread black and green twist, 17 threads slate.

Arrangement of filling. All black.

PROBLEM 7.

Stripe for Woolen, Worsted, or Cotton. 24 threads x 8 picks.

Section A.	4 threads	8 picks	C2.	
B.	8 ,,	8 ,,	C2.	Commence with the 2d thread and twill to left.
C.	4 ,,	8 ,,	C2.	
D.	8 ,,	8 ,,	C11.	Commence with the 2d thread.

NOTE. Mark C11 with red. Mark the 5th and 12th threads blue.

Arrangement of warp. 4 threads lavender, 1 thread black and green, 6 threads lavender, 1 thread black and orange, 12 threads lavender.

Arrangement of filling. All dark olive.

PROBLEM 8.

Fancy check for Woolen or Worsted. 48 threads x 48 picks.

Section A.	24 threads	24 picks	C2.	
	24 ,,	12 ,,	C5.	Commence with the 4th thread and twill to the left.
	24 ,,	12 ,,	C1.	Twill to left.
B.	12 ,,	36 ,,	C5.	Commence with the 4th thread and twill to the left.
	12 ,,	12 ,,	C1.	Twill to left.
C.	12 ,,	48 ,,	C1.	Twill to left.

NOTE. Mark C5 green. Mark 1C red.

Warp, all lavender. Filling, all brown.

PROBLEM 9.

Check for Woolen, Worsted, or Cotton. 48 threads x 48 picks.

Section A.	6 threads	36 picks	B1.	
	6 ,,	6 ,,	B2.	
	6 ,,	6 ,,	B1.	Twill to left.
		48		
	6 ,,	36 ,,	B1.	
	6 ,,	6 ,,	B1.	Twill to left.
	6 ,,	6 ,,	B2.	
		48		

6 threads	36 picks	B1.	
6 ,,	6 ,,	B2.	
6 ,,	6 ,,	B1.	Twill to left.
	48		
6 ,,	36 ,,	B1.	
6 ,,	6 ,,	B1.	Twill to left.
6 ,,	6 ,,	B2.	
	48		
6 ,,	36 ,,	B1.	
6 ,,	6 ,,	B2.	
6 ,,	6 ,,	B1.	Twill to left.
	48		
6 ,,	36 ,,	B1.	
6 ,,	6 ,,	B1.	Twill to left.
6 ,,	6 ,,	B2.	
	48		
6 ,,	6 ,,	B2.	
6 ,,	6 ,,	B1.	Twill to left.
6 ,,	6 ,,	B2.	
6 ,,	6 ,,	B1.	Twill to left.
6 ,,	6 ,,	B2.	
6 ,,	6 ,,	B1.	Twill to left.
6 ,,	6 ,,	B2.	
6 ,,	6 ,,	B1.	Twill to left.
	48		
6 ,,	6 ,,	B1.	Twill to left.
6 ,,	6 ,,	B2.	
6 ,,	6 ,,	B1.	Twill to left.
6 ,,	6 ,,	B2.	
6 ,,	6 ,,	B1.	Twill to left.
6 ,,	6 ,,	B2.	
6 ,,	6 ,,	B1.	Twill to left.
6 ,,	6 ,,	B2.	
	48		

NOTE. Mark B2 red. Mark B1, left twill, green.
Light warp, dark filling.

PROBLEM 10.

Stripe for Woolen, Worsted, or Cotton. 48 threads x 12 picks.

Section A.	12 threads	12 picks	B1.	
B.	3 ,,	12 ,,	B2.	
C.	6 ,,	12 ,,	B1.	
D.	3 ,,	12 ,,	B2.	
E.	12 ,,	12 ,,	B1.	
F.	6 ,,	6 ,,	B2.	
	6 ,,	6 ,,	B1.	Twill to left.
		12		
G.	6 ,,	6 ,,	B1.	Twill to left.
	6 ,,	6 ,,	B2.	
		12		

NOTE. Mark B2 blue. Mark B1, left twill, orange. Mark the risers on 24th and 25th threads and picks red.

Warp arrangement. 23 threads light lavender, 1 thread lavender and green twist, 1 thread lavender and orange twist, 23 threads lavender.

Filling arrangement. 23 picks olive, 1 pick olive and red, 1 pick olive and blue, 23 picks olive.

PROBLEM 11.

Fancy stripe for Woolen, Worsted, or Cotton. 32 threads x 40 picks.

Section A.	16 threads	40 picks	C2.	
	8 ,,	12 ,,	C3.	Commence with 3d thread, twill to left.
	8 ,,	8 ,,	C2.	Commence with 2d thread, twill to left.
	8 ,,	12 ,,	C1.	Twill to left.
	8 ,,	8 ,,		
		40		
	8 ,,	12 ,,	C1.	Twill to left.
	8 ,,	8 ,,	C2.	Commence with 2d thread, twill to left.
	8 ,,	12 ,,	C3.	Commence with 3d thread, twill to left.
	8 ,,	8 ,,	C2.	Commence with 2d thread, twill to left.
		40		

NOTE. Mark C2 to left, red. Mark C3 green. Mark C1 orange. Mark 5th, 8th, 11th threads blue.

Warp arrangement. 4 threads slate, 1 black and orange, 2 slate, 1 black and green, 2 slate, 1 black and orange, 21 slate. Filling, dark brown.

PROBLEM 12.

Overplaid and check for Woolen, Worsted, and Cotton.

48 threads x 48 picks.

Section A.	6 threads	12 picks	B1.	
	6 ,,	3 ,,	B2.	
	6 ,,	6 ,,	B1.	
	6 ,,	3 ,,	B2.	
	6 ,,	12 ,,	B1.	
	6 ,,	6 ,,	B2.	
	6 ,,	6 ,,	B1.	L. T.
		48		
Section B.	6 threads	12 picks	B1.	
	6 ,,	3 ,,	B2.	
	6 ,,	6 ,,	B1.	
	6 ,,	3 ,,	B2.	
	6 ,,	12 ,,	B1.	
	6 ,,	6 ,,	B1.	L. T
	6 ,,	6 ,,	B2.	
		48		
Section C.	3 threads	42 picks	B2.	
	3 ,,	6 ,,	B1.	L. T.
		48		
Section D.	6 threads	12 picks	B1.	
	6 ,,	3 ,,	B2.	
	6 ,,	6 ,,	B1.	
	6 ,,	3 ,,	B2.	
	6 ,,	12 ,,	B1.	
	6 ,,	6 ,,	B1.	L. T.
	6 ,,	6 ,,	B2.	
		48		

Section E.	3 threads	42 picks	B2.	
	3 ,,	6 ,,	B1.	L. T.
		48		

Section F.	6 threads	12 picks	B1.	
	6 ,,	3 ,,	B2.	
	6 ,,	6 ,,	B1.	
	6 ,,	3 ,,	B2.	
	6 ,,	12 ,,	B1.	
	6 ,,	6 ,,	B1.	L. T.
	6 ,,	6 ,,	B2.	
		48		

Section G.	6 threads	12 picks	B1.	
	6 ,,	3 ,,	B2.	
	6 ,,	6 ,,	B1.	
	6 ,,	3 ,,	B2.	
	6 ,,	12 ,,	B1.	
	6 ,,	6 ,,	B2.	
	6 ,,	6 ,,	B1.	L. T.
		48		

Section H.	6 threads	6 picks	B2.	
	6 ,,	6 ,,	B1.	L. T.
	6 ,,	3 ,,	B2.	
	6 ,,	6 ,,	B1.	L. T.
	6 ,,	3 ,,	B2.	
	6 ,,	6 ,,	B1.	L. T.
	6 ,,	6 ,,	B2.	
	6 ,,	6 ,,	B1.	L. T.
	6 ,,	6 ,,	B2.	
		48		

Section I.	6 threads	6 picks	B1.	L. T.
	6 ,,	6 ,,	B2.	
	6 ,,	3 ,,	B1.	L. T.
	6 ,,	6 ,,	B2.	
	6 ,,	3 ,,	B1.	L. T.
	6 ,,	6 ,,	B2.	
	6 ,,	6 ,,	B1.	L. T.
	6 ,,	6 ,,	B2.	
	6 ,,	6 ,,	B1.	L. T.
		48		

NOTE. Mark B2 red. Mark B1, left twill, green.

Arrangement of warp. 12 light, 1 twist, 10 light, 1 twist, 12 light, 1 twist, 4 light, 2 twist, 4 light, 1 twist.

Filling is arranged in the same order as the warp.

PROBLEM 13.

Check and spot effect for Woolen and Worsted. 48 threads x 48 picks.

Section A.	8 threads	8 picks	C2.	L. T.
	8 ,,	8 ,,	C11.	
	8 ,,	32 ,,	C2.	L. T.
		48		

Section B.	8 threads	8 picks	C11.	
	8 ,,	8 ,,	C2.	R. T.
	8 ,,	8 ,,	C11.	
	8 ,,	24 ,,	C2.	L. T.
		48		

Section C.	8 threads	8 picks	C2.	L. T.
	8 ,,	8 ,,	C11.	
	8 ,,	32 ,,	C2.	L. T.
		— 48		
Section D.	8 threads	32 picks	C2.	L. T.
	8 ,,	8 ,,	C11.	
	8 ,,	8 ,,	C2.	L. T.
		— 48		
Section E.	8 threads	24 picks	C2.	L. T.
	8 ,,	8 ,,	C11.	
	8 ,,	8 ,,	C2.	R. T.
	8 ,,	8 ,,	C11.	
		— 48		
Section F.	8 threads	32 picks	C2.	L. T.
	8 ,,	8 ,,	C11.	
	8 ,,	8 ,,	C2.	L. T.
		— 48		

NOTE. Mark C11 green. Mark C2, R. T., red. Mark the risers on the 12th, 13th, 36th, 37th threads and picks orange.

Arrangement of warp. 11 threads sage, 1 black and scarlet, 1 black and green, 22 sage, 1 black and green, 1 black and scarlet, 11 sage. Filling. Olive in place of sage, the other threads same as warp.

PROBLEM 14.

Check, or Overplaid, for Woolen, Worsted, Cotton, Linen, and Silk.
48 threads x 48 picks.

Section A.	24 threads	24 picks	C2.	
	24 ,,	8 ,,	C11.	
	24 ,,	8 ,,	C2.	L. T.
	24 ,,	8 ,,	C11.	
		— 48		
Section B.	8 threads	32 picks	C11.	
	8 ,,	8 ,,	C2.	L. T.
	8 ,,	8 ,,	C11.	
		— 48		
Section C.	8 threads	48 picks	C2.	L. T.
Section D.	8 threads	32 picks	C11.	
	8 ,,	8 ,,	C2.	L. T.
	8 ,,	8 ,,	C11.	
		— 48		

NOTE. Mark C11 blue; C2, L. T., red. Mark the risers on the 33d and 40th threads and picks with orange.

Arrangement of warp. 32 threads olive, 1 black and crimson, 6 threads olive, 1 black and crimson, 8 olive. Filling arrangement same as warp, using black in place of olive.

PROBLEM 15.

Fancy broken twill effect, for Woolen, Worsted, Cotton and Linen.
64 threads x 64 picks.

Section A.	8 threads	16 picks	C2.	2d thread.	
	8 ,,	16 ,,	C2.	L. T.	2d pick.
	8 ,,	8 ,,	C11.		
	8 ,,	16 ,,	C2.	L. T.	
	8 ,,	8 ,,	C.		
		— 64			

Section B	8 threads	8 picks	C2.	L. T. 2d pick.
	8 ,,	24 ,,	C2.	2d thread.
	8 ,,	16 ,,	C2.	L. T. 2d pick.
	8 ,,	8 ,,	C11.	
	8 ,,	8 ,,	C2.	L. T. 2d pick.
		64		
Section C.	8 threads	8 picks	C11.	
	8 ,,	16 ,,	C2.	L. T. 2d pick.
	8 ,,	24 ,,	C2.	2d thread
	8 ,,	16 ,,	C2.	L. T. 2d pick.
		64		
Section D.	8 threads	16 picks	C2.	L. T. 2d pick.
	8 ,,	8 ,,	C11.	
	8 ,,	16 ,,	C2.	L. T. 2d pick.
	8 ,,	24 ,,	C2.	2d thread.
		64		
Section E.	8 threads	8 picks	C2.	L. T. 2d pick.
	8 ,,	24 ,,	C2.	2d thread.
	8 ,,	16 ,,	C2.	L. T. 2d pick.
	8 ,,	8 ,,	C11.	
	8 ,,	8 ,,	C2.	L. T. 2d pick.
		64		
Section F.	8 threads	16 picks	C2.	2d thread.
	8 ,,	16 ,,	C2.	2d pick.
	8 ,,	8 ,,	C11.	
	8 ,,	16 ,,	C2.	L. T. 2d pick.
	8 ,,	8 ,,	C2.	2d thread.
		64		
Section G.	8 threads	16 picks	C2.	L. T. 2d pick.
	8 ,,	8 ,,	C11.	
	8 ,,	16 ,,	C2.	L. T. 2d pick.
	8 ,,	24 ,,	C2.	2d thread.
		64		
Section H.	8 threads	8 picks	C11.	
	8 ,,	16 ,,	C2.	L. T. 2d pick.
	8 ,,	24 ,,	C2.	2d thread.
	8 ,,	16 ,,	C2.	L. T. 2d pick.
		64		

NOTE. Mark C11 orange; C2, left twill, blue.
Warp, light. Filling, dark.

PROBLEM 16.

Herringbone stripe for Woolen and Worsted. 80 threads x 10 picks.

Section A.	5 threads	10 picks	D3.	
B.	5 ,,	10 ,,	D5.	3d thread L. T.
C.	5 ,,	10 ,,	D3.	
D.	5 ,,	10 ,,	D5.	3d thread L. T.

E.	5 threads	10 picks	D3.		
F.	5 ,,	10 ,,	D5.	3d thread	L. T.
G.	25 ,,	10 ,,	D3.		
H.	25 ,,	10 ,,	D5.	3d thread	L. T.

NOTE. Mark D5 red.
Warp, light. Filling, dark. Also, piece dyed.

PROBLEM 17.

Fancy stripe for Woolen and Worsted. 64 threads x 24 picks.

Section A.	16 threads	24 picks	C2.	2d pick.
B.	16 ,,	24 ,,	C190.	
C.	16 ,,	24 ,,	C2.	
D.	16 ,,	24 ,,	C11.	2d thread.

NOTE. Mark G190 red. Mark C11 green.
Warp, light. Filling, dark.

PROBLEM 18.

Check for Woolen and Worsted. 64 threads x 64 picks.

Section A.	32 threads	32 picks	G80.	7th thread.	L. T.
	32 ,,	32 ,,	G63.	8th thread.	
		64			
B.	32 ,,	32 ,,	G63.	2d thread.	
	32 ,,	32 ,,	G80.	5th thread.	L. T.
		64			

NOTE. Mark G63 red. Piece dyed.

PROBLEM 19.

Twill or diagonal effect. 64 threads x 64 picks.

Section A.	16 threads	32 picks	G63.	
	16 ,,	32 ,,	G85.	6 thread, L. T.
		64		
Section B.	16 ,,	16 ,,	G80.	6 thread, L. T.
	16 ,,	32 ,,	G63.	
	16 ,,	16 ,,	G80.	6 thread, L. T.
		64		
Section C.	16 ,,	32 ,,	G80.	
	16 ,,	32 ,,	G63.	
		64		
Section D.	16 ,,	16 ,,	G63.	
	16 ,,	32 ,,	G80.	6 thread, L. T.
	16 ,,	16 ,,	G63.	
		64		

NOTE. Mark G85 red. Piece dyed.

PROBLEM 20.

Fancy twill and basket stripe. 96 threads x 16 picks.

Section A.	8 threads	16 picks	G15.	8th pick, L. T.
B.	8 ,,	16 ,,	G15.	R. T.
C.	8 ,,	16 ,,	G15.	L. T.
D.	16 ,,	16 ,,	G126.	
E.	16 ,,	16 ,,	G15.	R. T.
F.	16 ,,	16 ,,	G15.	L. T.
G.	16 ,,	16 ,,	G126.	
H.	8 ,,	16 ,,	G15.	R. T.

NOTE. Mark left twill, green, G15. Mark G126 red.

The student must now commence to arrange the weaves with the least possible float or flush, the twill weaves and basket weaves to be arranged so that they will cut. Light warp, dark filling.

PROBLEM 21.

Running basket spot effect for Worsted. 96 threads x 96 picks.

Section A.	16 threads	16 picks	G40, 4th thread.
	16 ,,	16 ,,	G67, L. T.
	16 ,,	64 ,,	G40, 4th thread.
		96	
Section B.	16 threads	16 picks	G40.
	16 ,,	16 ,,	G67.
	16 ,,	16 ,,	G40.
	16 ,,	48 ,,	G67.
		96	
Section C.	16 threads	16 picks	G40.
	16 ,,	16 ,,	G67.
	16 ,,	64 ,,	G40.
		96	
Section D.	16 threads	64 picks	G40.
	16 ,,	16 ,,	G67.
	16 ,,	16 ,,	G40.
		96	
Section E.	16 threads	48 picks	G40.
	16 ,,	16 ,,	G67.
	16 ,,	16 ,,	G40.
	16 ,,	16 ,,	G67.
		96	
Section F.	16 threads	64 picks	G40.
	16 ,,	16 ,,	G67.
	16 ,,	16 ,,	G40
		96	

NOTE. Mark 40G red. Piece dyed.

PROBLEM 22.

Spot effect. Woolen and Worsted. 64 threads x 64 picks.

Section A.	8 threads	8 picks	C2.	3d thread.
	8 ,,	8 ,,	C60.	2d pick.
	8 ,,	48 ,,	C2.	3d thread.
		64		

Section B.	8 threads	8 picks	C2.	3 T.
	8 ,,	24 ,,	C60.	2 P.
	8 ,,	32 ,,	C2.	3 T.
		64		
Section C.	8 threads	24 picks	C60.	2 P.
	8 ,,	40 ,,	C2.	3 T.
		64		
Section D.	8 threads	16 picks	C2.	3 T.
	8 ,,	8 ,,	C60.	2 P.
	8 ,,	40 ,,	C2.	3 T.
		64		
Section E.	8 threads	40 picks	C2.	3T.
	8 ,,	8 ,,	C60.	2 P.
	8 ,,	16 ,,	C2.	3 T.
		64		
Section F.	8 threads	40 picks	C2.	3 T.
	8 ,,	24 ,,	C60.	2 P.
		64		
Section G.	8 threads	32 picks	C2.	3 T.
	8 ,,	24 ,,	C60.	2 P.
	8 ,,	8 ,,	C2.	3 T.
		64		
Section H.	8 threads	48 picks	C2.	3 T.
	8 ,,	8 ,,	C60.	2 P.
	8 ,,	8 ,,	C2.	3 T.
		64		

NOTE. Mark C60 red. Light warp, dark filling.

PROBLEM 23.

Basket check suiting. Woolen and Worsted. 64 threads x 64 picks.

Section A.	24 threads	24 picks	C11.	2 T.	2 P.
	24 ,,	8 ,,	C60.		
	24 ,,	16 ,,	C11.	2 T.	2 P.
	24 ,,	8 ,,	C60.		
	24 ,,	8 ,,	C11.	2 T.	2 P.
		64			
Section B.	8 threads	64 picks	C60.		
Section C.	16 threads	24 picks	C11.	2 T.	2 P.
	16 ,,	8 ,,	C60.		
	16 ,,	16 ,,	C11.	2 T.	2 P.
	16 ,,	8 ,,	C60.		
	16 ,,	8 ,,	C11.	2 T.	2 P.
		64			
Section D.	8 threads	64 picks	C60.		

Section E.	8 threads	24 picks	C11.	2 T.	2 P.
	8 ,,	8 ,,	C60.		
	8 ,,	16 ,,	C11.	2 T.	2 P.
	8 ,,	8 ,,	C60.		
	8 ,,	8 ,,	C11.	2 T.	2 P.
		64			

NOTE. Mark C11 red.

PROBLEM 24.

Fancy check. Woolen and Worsted. 64 threads x 64 picks.

Section A.	16 threads	16 picks	C11.	2 T.	2 P.
	16 ,,	8 ,,	C2.	2 P.	
	16 ,,	8 ,,	C60.		
	16 ,,	16 ,,	C11.	2 T.	2 P.
	16 ,,	8 ,,	C60.		
	16 ,,	8 ,,	C2.	2 P.	
		64			
Section B.	8 threads	64 picks	C60.		
Section C.	8 threads	24 picks	C2.	2 P.	
	8 ,,	8 ,,	C60.		
	8 ,,	16 ,,	C2.	2 P.	
	8 ,,	8 ,,	C60.		
	8 ,,	8 ,,	C2.	2 P.	
		64			
Section D.	16 threads	16 picks	C11.	2 T.	2 P.
	16 ,,	8 ,,	C2.	2 P.	
	16 ,,	8 ,,	C60.		
	16 ,,	16 ,,	C11.	2 T.	2 P.
	16 ,,	8 ,,	C60.		
	16 ,,	8 ,,	C2.	2 P.	
		64			
Section E.	8 threads	24 picks	C2.	2 P.	
	8 ,,	8 ,,	C60.		
	8 ,,	16 ,,	C2.	2 P.	
	8 ,,	8 ,,	C60.		
	8 ,,	8 ,,	C2.	2 P.	
		64			
Section F.	8 threads	64 picks	C60.		

NOTE. Mark C11 green; C60 red.

PROBLEM 25.

Fancy stripe. Woolen, Worsted, and Cotton. 64 threads x 16 picks.

Section A.	8 threads	16 picks	C2.	2 T.	L. T.
B.	8 ,,	16 ,,	C24.	2 P.	
C.	4 ,,	16 ,,	C2.	2 T.	L. T.
D.	4 ,,	16 ,,	C24.	2P.	
E.	8 ,,	16 ,,	C2.	2 T.	L. T.

F.	8 threads	16 picks	C60.	8 P.
G.	8 ,,	16 ,,	C24.	2 P.
H.	4 ,,	16 ,,	C60.	4 P.
I.	4 ,,	16 ,,	C24.	2 P.
J.	8 ,,	16 ,,	C60.	4 P.

NOTE. Mark C24 red. C60 green.

PROBLEM 26.

Fancy stripe. Woolen, Worsted, and Cotton. 64 threads x 16 picks.

Section A.	8 threads	16 picks	C60.	
B.	8 ,,	16 ,,	C66.	2 P.
C.	4 ,,	16 ,,	C60.	
D.	4 ,,	16 ,,	C66.	2 P.
E.	8 ,,	16 ,,	C60.	
F.	8 ,,	16 ,,	C2.	2 P.
G.	8 ,,	16 ,,	C66.	2 P.
H.	4 ,,	16 ,,	C2.	2 P.
I.	4 ,,	16 ,,	C66.	2 P.
J.	8 ,,	16 ,,	C2.	2 P.

NOTE. Mark C66 red. C2 green.

PROBLEM 27.

Fancy rib and warp spot. Woolen and worsted.
64 threads x 64 picks.

Section A.	8 threads	8 picks	C16.	
	8 ,,	8 ,,	C8.	
	8 ,,	4 ,,	C16.	
	8 ,,	4 ,,	C8.	
	8 ,,	40 ,,	C16.	
		64		
Section B.	8 threads	32 picks	C8.	
	8 ,,	8 ,,	C16.	
	8 ,,	16 ,,	C12.	3 T. 3 P.
	8 ,,	8 ,,	C16.	
		64		
Section C.	4 threads	8 picks	C16.	
	4 ,,	8 ,,	C8.	
	4 ,,	4 ,,	C16.	
	4 ,,	4 ,,	C8.	
	4 ,,	40 ,,	C16.	
		64		

Section D.	4 threads	32 picks	C8.	
	4 ,,	8 ,,	C16.	
	4 ,,	16 ,,	C12.	3 T. 3 P.
	4 ,,	8 ,,	C16.	
		64		
Section E.	8 threads	8 picks	C16.	
	8 ,,	8 ,,	C8.	
	8 ,,	4 ,,	C16.	
	8 ,,	4 ,,	C8.	
	8 ,,	40 ,,	C16.	
		64		
Section F.	8 threads	40 picks	C16.	
	8 ,,	8 ,,	C8.	
	8 ,,	4 ,,	C16.	
	8 ,,	4 ,,	C8.	
	8 ,,	8 ,,	C16.	
		64		
Section G.	8 threads	8 picks	C16.	
	8 ,,	16 ,,	C12.	3 T. 3 P.
	8 ,,	8 ,,	C16.	
	8 ,,	32 ,,	C8.	
		64		
Section H.	4 threads	40 picks	C16.	
	4 ,,	8 ,,	C8.	
	4 ,,	4 ,,	C16.	
	4 ,,	4 ,,	C8.	
	4 ,,	8 ,,	C16.	
		64		
Section I.	4 threads	8 picks	C16.	
	4 ,,	16 ,,	C12.	3 T. 3 P.
	4 ,,	8 ,,	C16.	
	4 ,,	32 ,,	C8.	
		64		
Section J.	8 threads	40 picks	C16.	
	8 ,,	8 ,,	C8.	
	8 ,,	4 ,,	C16.	
	8 ,,	4 ,,	C8.	
	8 ,,	8 ,,	C16.	
		64		

NOTE. Mark C8 blue. Mark C12 orange.

PROBLEM 28.

Broken stripe, Woolen and Worsted. 64 threads x 32 picks.

Section A.	8 threads	24 picks	C60.	2 T. 2 P.
	8 ,,	8 ,,	C2.	4 T. L.T.
		32		
Section B.	8 threads	24 picks	C2.	4 T. L.T.
	8 ,,	8 ,,	C60.	2 T. 2 P.
		32		

Section C.	4 threads	24 picks	C60.	2 T. 2 P.
	4 ,,	8 ,,	C2.	4 T. L.T.
		32		
Section D.	4 threads	24 picks	C2.	4 T. L.T.
	4 ,,	8 ,,	C60.	2 T. 2 P.
		32		
Section E.	8 threads	24 picks	C60.	2 T. 2 P.
	8 ,,	8 ,,	C2.	4 T. L.T.
		32		
Section F.	8 threads	8 picks	C2.	4 T. L.T.
	8 ,,	24 ,,	C60.	2 T. 2 P.
		32		
Section G.	8 threads	8 picks	C60.	2 T. 2 P.
	8 ,,	24 ,,	C2.	4 T. L.T.
		32		
Section H.	4 threads	8 picks	C2.	4 T. L.T.
	4 ,,	24 ,,	C60.	2 T. 2 P.
		32		
Section I.	4 threads	8 picks	C60.	2 T. 2 P.
	4 ,,	24 ,,	C2.	4 T. L.T.
		32		
Section J.	8 threads	8 picks	C2.	4 T. L.T.
	8 ,,	24 ,,	C60.	2 T. 2 P.
		32		

NOTE. Mark C60 red.
Light warp. Dark filling.

PROBLEM 30.

Spot and check effect. 64 threads x 64 picks.

Section A.	8 threads	8 picks	C2.	
	8 ,,	8 ,,	C61.	
	8 ,,	4 ,,	C2.	
	8 ,,	4 ,,	C61.	5 P.
	8 ,,	16 ,,	C2.	
	8 ,,	8 ,,	C6.	2 T. L.T.
	8 ,,	4 ,,	C2.	
	8 ,,	4 ,,	C6.	2 T. L.T.
	8 ,,	8 ,,	C2.	
		64		
Section B.	8 threads	32 picks	C61.	
	8 ,,	32 ,,	C6.	2 T. L.T.
		64		
Section C.	4 threads	8 picks	C2.	
	4 ,,	8 ,,	C61.	
	4 ,,	4 ,,	C2.	
	4 ,,	4 ,,	C61.	5 P.
	4 ,,	16 ,,	C2.	
	4 ,,	8 ,,	C6.	2 T. L.T.
	4 ,,	4 ,,	C2.	
	4 ,,	4 ,,	C6.	2 T. L.T.
	4 ,,	8 ,,	C2.	
		64		

Section D.	4 threads	32 picks	C61.	
	4 ,,	32 ,,	C6.	2 T. L.T.
		—		
		64		
Section E.	8 threads	8 picks	C2.	
	8 ,,	8 ,,	C61.	
	8 ,,	4 ,,	C2.	
	8 ,,	4 ,,	C61.	5 P.
	8 ,,	16 ,,	C2.	
	8 ,,	8 ,,	C6.	2 T. L.T.
	8 ,,	4 ,,	C2.	
	8 ,,	4 ,,	C6.	2 T. L.T.
	8 ,,	8 ,,	C2.	
		—		
		64		
Section F.	8 threads	8 picks	C2.	
	8 ,,	8 ,,	C6.	2 T. L.T.
	8 ,,	4 ,,	C2.	
	8 ,,	4 ,,	C6.	2 T. L.T.
	8 ,,	16 ,,	C2.	
	8 ,,	8 ,,	C61.	
	8 ,,	4 ,,	C2.	
	8 ,,	4 ,,	C61.	5 P.
	8 ,,	8 ,,	C2.	
		—		
		64		
Section G.	8 threads	32 picks	C6.	2 T. L.T.
	8 ,,	32 ,,	C61.	
		—		
		64		
Section H.	4 threads	8 picks	C2.	
	4 ,,	8 ,,	C6.	2 T. L.T.
	4 ,,	4 ,,	C2.	
	4 ,,	4 ,,	C6.	2 T. L.T.
	4 ,,	16 ,,	C2.	
	4 ,,	8 ,,	C61.	
	4 ,,	4 ,,	C2.	
	4 ,,	4 ,,	C61.	5 P.
	4 ,,	8 ,,	C2.	
		—		
		64		
Section I,	4 threads	32 picks	C6.	2 T. L.T.
	4 ,,	32 ,,	C61.	
		—		
		64		
Section J.	8 threads	8 picks	C2.	
	8 ,,	8 ,,	C6.	2 T. L.T.
	8 ,,	4 ,,	C2.	
	8 ,,	4 ,,	C6.	2 T. L.T.
	8 ,,	16 ,,	C2.	
	8 ,,	8 ,,	C61.	
	8 ,,	4 ,,	C2.	
	8 ,,	4 ,,	C61.	5 P.
	8 ,,	8 ,,	C2.	
		—		
		64		

NOTE. Mark C61 red. Mark C6 green.

PROBLEM 31.

Fancy check, Woolen and Worsted. 64 threads x 64 picks.

Section A.	32 threads	32 picks	C11.	2 T. 2 P.
	32 ,,	8 ,,	C2.	2 P. L.T.
	32 ,,	8 ,,	C61.	
	32 ,,	4 ,,	C2.	2 T. 2 P.
	32 ,,	4 ,,	C61.	5 P.
	32 ,,	8 ,,	C2.	2 T. 2 P.
		64		

Section B.	8 threads	40 picks	C2.	2 P. L.T.
	8 ,,	8 ,,	C61.	
	8 ,,	4 ,,	C2.	2 P. L.T.
	8 ,,	4 ,,	C61.	5 P.
	8 ,,	8 ,,	C2.	2 P. L.T.
		64		

Section C.	8 threads	64 picks	C61.	
Section D.	4 threads	40 picks	C2.	2 P. L.T.
	4 ,,	8 ,,	C61.	
	4 ,,	4 ,,	C2.	2 P. L.T.
	4 ,,	4 ,,	C61.	5 P.
	4 ,,	8 ,,	C2.	2 P. L.T.
		64		

Section E.	4 threads	64 picks	C61.	
Section F.	8 threads	40 picks	C2.	2 P. L.T.
	8 ,,	8 ,,	C61.	
	8 ,,	4 ,,	C2.	2 P. L.T.
	8 ,,	4 ,,	C61.	5 P.
	8 ,,	8 ,,	C2.	2 P. L.T.
		64		

NOTE. Mark C2 red. Mark C61 green.

PROBLEM 32.

Allover effect. Woolen and Worsted. 80 threads x 80 picks.

Section A.	8 threads	8 picks	C12.	3 T. 3 P.
	8 ,,	4 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	8 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	20 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	16 ,,	C16.	
		80		

Section B.	4 threads	8 picks	C16.	
	4 ,,	8 ,,	C12.	3 T. 3 P.
	4 ,,	20 ,,	C16.	
	4 ,,	8 ,,	C12.	3 T. 3 P.
	4 ,,	16 ,,	C16.	
	4 ,,	8 ,,	C12.	3 T. 3 P.
	4 ,,	4 ,,	C16.	
	4 ,,	8 ,,	C12.	3 T. 3 P.
		80		

Section C.	8 threads	16 picks	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	16 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	4 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	8 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	4 ,,	C16.	
		80		
Section D.	8 threads	4 picks	C12.	3 T. 3 P.
	8 ,,	16 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	4 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	8 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	20 ,,	C16.	
	8 ,,	4 ,,	C12.	3 T. 3 P.
		80		
Section E.	4 threads	16 picks	C16.	3 T. 3 P.
	4 ,,	8 ,,	C12.	
	4 ,,	16 ,,	C16.	3 T. 3 P.
	4 ,,	8 ,,	C12.	
	4 ,,	4 ,,	C16.	3 T. 3 P.
	4 ,,	8 ,,	C12.	
	4 ,,	8 ,,	C16.	3 T. 3 P.
	4 ,,	8 ,,	C12.	
	4 ,,	4 ,,	C16.	3 T. 3 P.
		80		
Section F.	8 threads	8 picks	C12.	3 T. 3 P.
	8 ,,	4 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	8 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	20 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	16 ,,	C16.	
		80		
Section G.	8 threads	8 picks	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	20 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	16 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	4 ,,	C16.	
	8 ,,	8 ,,	C12.	5 T. 3 P.
		80		
Section H.	4 threads	8 picks	C12.	3 T. 3 P
	4 ,,	4 ,,	C16.	
	4 ,,	8 ,,	C12.	3 T. 3 P.
	4 ,,	8 ,,	C16.	
	4 ,,	8 ,,	C12.	3 T. 3 P.
	4 ,,	20 ,,	C16.	
	4 ,,	8 ,,	C12.	3 T. 3 P.
	4 ,,	16 ,,	C16.	
		80		

Section I.	8 threads	4 picks	C12.	3 T. 3 P.
	8 ,,	16 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	4 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	8 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	20 ,,	C16.	
	8 ,,	4 ,,	C12.	3 T. 3 P.
		80		
Section J.	8 threads	16 picks	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	16 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	4 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	8 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	4 ,,	C16.	
		80		
Section K.	4 threads	4 picks	C12.	3 T. 3 P.
	4 ,,	16 ,,	C16.	
	4 ,,	8 ,,	C12.	3 T. 3 P.
	4 ,,	4 ,,	C16.	
	4 ,,	8 ,,	C12.	3 T. 3 P.
	4 ,,	8 ,,	C16.	
	4 ,,	8 ,,	C12.	3 T. 3 P.
	4 ,,	20 ,,	C16.	
	4 ,,	4 ,,	C12.	3 T. 3 P.
		80		
Section L.	8 threads	8 picks	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	20 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	16 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
	8 ,,	4 ,,	C16.	
	8 ,,	8 ,,	C12.	3 T. 3 P.
		80		

NOTE. Mark C16 red.

PROBLEM 33.

Fancy check. Woolen and Worsted. 80 threads x 80 picks.

Section A.	8 threads	80 picks	C57.	
Section B.	4 threads	12 picks	C2.	3 P. L.T.
	4 ,,	4 ,,	C57.	
	4 ,,	8 ,,	C11.	2 T. 2 P.
	4 ,,	8 ,,	C57.	
	4 ,,	16 ,,	C2	3 P. L.T.
	4 ,,	8 ,,	C11.	2 T. 2 P.
	4 ,,	8 ,,	C57.	
	4 ,,	8 ,,	C11.	2 T. 2 P.
	4 ,,	8 ,,	C2.	3 P. L.T.
		80		

Section C.	8 threads	8 picks	C2.	3 P. L.T.
	8 ,,	4 ,,	C11.	2 T. 2 P.
	8 ,,	4 ,,	C57.	
	8 ,,	8 ,,	C2.	3 P. L.T.
	8 ,,	8 ,,	C57.	
	8 ,,	8 ,,	C2.	3 P. L.T.
	8 ,,	8 ,,	C11.	2 T. 2 P.
	8 ,,	8 ,,	C2.	3 P. L.T.
	8 ,,	8 ,,	C57.	
	8 ,,	8 ,,	C2.	3 P. L.T.
	8 ,,	8 ,,	C11.	2 T. 2 P.
		80		
Section D.	8 threads	8 picks	C11.	2 T. 2 P.
	8 ,,	4 ,,	C2.	3 P. L.T.
	8 ,,	4 ,,	C57.	
	8 ,,	8 ,,	C2.	3 P. L.T.
	8 ,,	8 ,,	C57.	
	8 ,,	8 ,,	C11.	2 T. 2 P.
	8 ,,	16 ,,	C2.	3 P. L.T.
	8 ,,	8 ,,	C57.	
	8 ,,	16 ,,	C2.	3 P. L.T.
		80		
Section E.	4 threads	8 picks	C2.	3 P. L.T.
	4 ,,	4 ,,	C11.	2 T. 2 P.
	4 ,,	4 ,,	C57.	
	4 ,,	8 ,,	C2.	3 P. L.T.
	4 ,,	8 ,,	C57.	
	4 ,,	8 ,,	C2.	3 P. L.T.
	4 ,,	8 ,,	C11.	2 T. 2 P.
	4 ,,	8 ,,	C2.	3 P. L.T.
	4 ,,	8 ,,	C57.	
	4 ,,	8 ,,	C2.	3 P. L.T.
	4 ,,	8 ,,	C11.	2 T. 2 P.
		80		
Section F.	8 threads	80 picks	C57.	
Section G.	8 threads	12 picks	C2.	3 P. L.T.
	8 ,,	4 ,,	C57.	
	8 ,,	8 ,,	C11.	2 T. 2 P.
	8 ,,	8 ,,	C57.	
	8 ,,	16 ,,	C2.	3 P. L.T.
	8 ,,	8 ,,	C11.	2 T. 2 P.
	8 ,,	8 ,,	C57.	
	8 ,,	8 ,,	C11.	2 T. 2 P.
	8 ,,	8 ,,	C2.	3 P. L.T.
		80		
Section H.	4 threads	80 picks	C57.	
Section I.	8 threads	8 picks	C11.	2 T. 2 P.
	8 ,,	4 ,,	C2.	3 P. L.T.
	8 ,,	4 ,,	C57.	
	8 ,,	8 ,,	C2.	3 P. L.T.
	8 ,,	8 ,,	C57.	
	8 ,,	8 ,,	C11.	2 T. 2 P.
	8 ,,	16 ,,	C2.	3 P. L.T.
	8 ,,	8 ,,	C57.	
	8 ,,	16 ,,	C2.	3 P. L.T.
		80		

Section J.	8 threads	8 picks	C2.	3 P. L.T.
	8 ,,	4 ,,	C11.	2 T. 2 P.
	8 ,,	4 ,,	C57.	
	8 ,,	8 ,,	C2.	3 P. L.T.
	8 ,,	8 ,,	C57.	
	8 ,,	8 ,,	C2.	3 P. L.T.
	8 ,,	8 ,,	C11.	2 T. 2 P.
	8 ,,	8 ,,	C2.	3 P. L.T.
	8 ,,	8 ,,	C57.	
	8 ,,	8 ,,	C2.	3 P. L.T.
	8 ,,	8 ,,	C11.	2 T. 2 P.
		80		
Section K.	4 threads	8 picks	C11.	2 T. 2 P.
	4 ,,	4 ,,	C2.	3 P. L.T.
	4 ,,	4 ,,	C57.	
	4 ,,	8 ,,	C2.	3 P. L.T.
	4 ,,	8 ,,	C57.	
	4 ,,	8 ,,	C11.	2 T. 2 P.
	4 ,,	16 ,,	C2.	3 P. L.T.
	4 ,,	8 ,,	C57.	
	4 ,,	16 ,,	C2.	3 P. L.T.
		80		
Section L.	8 threads	12 picks	C2.	3 P. L.T.
	8 ,,	4 ,,	C57.	
	8 ,,	8 ,,	C11.	2 T. 2 P.
	8 ,,	8 ,,	C57.	
	8 ,,	16 ,,	C2.	3 P. L.T.
	8 ,,	8 ,,	C11.	2 T. 2 P.
	8 ,,	8 ,,	C57.	
	8 ,,	8 ,,	C11.	2 T. 2 P.
	8 ,,	8 ,,	C2.	3 P. L.T.
		80		

NOTE. Mark C11 red. Mark C57 green.
Light olive warp. Black filling.

PROBLEM 34.

Allover effect. Woolen and Worsted.

Section A.	8 threads	20 picks	C17.	3 P.
	8 ,,	8 ,,	C60.	4 P. L. T.
	8 ,,	8 ,,	C17.	3 P.
	8 ,,	20 ,,	C60.	4 P. L. T.
	8 ,,	8 ,,	C17.	3 P.
	8 ,,	16 ,,	C60.	8 P. L. T.
		80		
Section B.	4 threads	8 picks	C60.	
	4 ,,	8 ,,	C17.	
	4 ,,	20 ,,	C60.	
	4 ,,	8 ,,	C17.	
	4 ,,	16 ,,	C60.	
	4 ,,	20 ,,	C17.	
		80		
Section C.	8 threads	16 picks	C60.	
	8 ,,	8 ,,	C17.	
	8 ,,	16 ,,	C60.	
	8 ,,	20 ,,	C17.	
	8 ,,	8 ,,	C60.	
	8 ,,	8 ,,	C17.	
	8 ,,	4 ,,	C60.	
		80		

Section D.	8 threads	4 picks	C17.
	8 ,,	16 ,,	C60.
	8 ,,	20 ,,	C17.
	8 ,,	8 ,,	C60.
	8 ,,	8 ,,	C17.
	8 ,,	20 ,,	C60.
	8 ,,	4 ,,	C17.
		80	
Section E.	4 threads	16 picks	C60.
	4 ,,	8 ,,	C17.
	4 ,,	16 ,,	C60.
	4 ,,	20 ,,	C17.
	4 ,,	8 ,,	C60.
	4 ,,	8 ,,	C17.
	4 ,,	4 ,,	C60.
		80	
Section F.	8 threads	20 picks	C17.
	8 ,,	8 ,,	C60.
	8 ,,	8 ,,	C17.
	8 ,,	20 ,,	C60.
	8 ,,	8 ,,	C17.
	8 ,,	16 ,,	C60.
		80	
Section G.	8 threads	8 picks	C60.
	8 ,,	8 ,,	C17.
	8 ,,	20 ,,	C60.
	8 ,,	8 ,,	C17.
	8 ,,	16 ,,	C60.
	8 ,,	20 ,,	C17.
		80	
Section H.	4 threads	20 picks	C17.
	4 ,,	8 ,,	C60.
	4 ,,	8 ,,	C17.
	4 ,,	20 ,,	C60.
	4 ,,	8 ,,	C17.
	4 ,,	16 ,,	C60.
		80	
Section I.	8 threads	4 picks	C17.
	8 ,,	16 ,,	C60.
	8 ,,	20 ,,	C17.
	8 ,,	8 ,,	C60.
	8 ,,	8 ,,	C17.
	8 ,,	20 ,,	C60.
	8 ,,	4 ,,	C17.
		80	
Section J.	8 threads	16 picks	C60.
	8 ,,	8 ,,	C17.
	8 ,,	16 ,,	C60.
	8 ,,	20 ,,	C17.
	8 ,,	8 ,,	C60.
	8 ,,	8 ,,	C17.
	8 ,,	4 ,,	C60.
		80	

Section K.	4 threads	4 picks	C17.
	4 ,,	16 ,,	C60.
	4 ,,	20 ,,	C17.
	4 ,,	8 ,,	C60.
	4 ,,	8 ,,	C17.
	4 ,,	20 ,,	C60.
	4 ,,	4 ,,	C17.
		80	
Section L.	8 threads	8 picks	C60.
	8 ,,	8 ,,	C17.
	8 ,,	20 ,,	C60.
	8 ,,	8 ,,	C17.
	8 ,,	16 ,,	C60.
	8 ,,	20 ,,	C17.
		80	

NOTE. Mark C60 red.

Arrangement of warp. 4 threads black, 2 black and white, 1 black and gold, 1 black and white.

Arrangement of filling. 4 picks brown, 2 black and lavender, 1 black and green, 1 black and lavender.

PROBLEM 35.

Allover effect. 120 threads x 120 picks.

Section A.	12 threads	30 picks	E5.	
	12 ,,	12 ,,	E4.	3 P.
	12 ,,	12 ,,	E5.	3 P.
	12 ,,	30 ,,	E4.	3 P.
	12 ,,	18 ,,	E5.	
	12 ,,	18 ,,	E4.	3 P.
		120		
Section B.	6 threads	12 picks	E4.	
	6 ,,	12 ,,	E5.	
	6 ,,	30 ,,	E4.	
	6 ,,	18 ,,	E5.	3 P.
	6 ,,	18 ,,	E4.	
	6 ,,	30 ,,	E5.	3 P.
		120		
Section C.	12 threads	24 picks	E4.	
	12 ,,	18 ,,	E5.	
	12 ,,	18 ,,	E4.	3 P.
	12 ,,	30 ,,	E5.	3 P.
	12 ,,	12 ,,	E4.	3 P.
	12 ,,	12 ,,	E5.	3 P.
	12 ,,	6 ,,	E4.	3 P.
		120		
Section D.	12 threads	12 picks	E5.	
	12 ,,	18 ,,	E4.	
	12 ,,	30 ,,	E5.	3 P.
	12 ,,	12 ,,	E4.	3 P.
	12 ,,	12 ,,	E5.	3 P.
	12 ,,	30 ,,	E4.	3 P.
	12 ,,	6 ,,	E5.	3 P.
		120		

NOTE. Mark E4 red.

This design has to be completed by the student.

Same move as Design No. 34. It must be noticed that the weave is half as large again as at No. 34.

PROBLEM 36.

Allover effect. 160 threads x 160 picks.

Section A.	16 threads	16 picks	G19.
	16 ,,	8 ,,	G130.
	16 ,,	16 ,,	G19.
	16 ,,	8 ,,	G130.
	16 ,,	24 ,,	G19.
	16 ,,	32 ,,	G130.
	16 ,,	24 ,,	G19.
	16 ,,	8 ,,	G130.
	16 ,,	8 ,,	G19.
	16 ,,	16 ,,	G130.
		160	
Section B.	8 threads	8 picks	G130.
	8 ,,	24 ,,	G19.
	8 ,,	32 ,,	G130.
	8 ,,	24 ,,	G19.
	8 ,,	8 ,,	G130.
	8 ,,	8 ,,	G19.
	8 ,,	16 ,,	G130.
	8 ,,	16 ,,	G19.
	8 ,,	8 ,,	G130.
	8 ,,	16 ,,	G19.
		160	
Section C.	16 threads	24 picks	G130.
	16 ,,	24 ,,	G19.
	16 ,,	8 ,,	G130.
	16 ,,	8 ,,	G19.
	16 ,,	16 ,,	G130.
	16 ,,	16 ,,	G19.
	16 ,,	8 ,,	G130.
	16 ,,	16 ,,	G19.
	16 ,,	8 ,,	G130.
	16 ,,	24 ,,	G19.
	16 ,,	8 ,,	G130.
		160	
Section D.	16 threads	8 picks	G19.
	16 ,,	8 ,,	G130.
	16 ,,	8 ,,	G19.
	16 ,,	16 ,,	G130.
	16 ,,	16 ,,	G19.
	16 ,,	8 ,,	G130.
	16 ,,	16 ,,	G19.
	16 ,,	8 ,,	G130.
	16 ,,	24 ,,	G19.
	16 ,,	32 ,,	G130.
	16 ,,	16 ,,	G19.
		160	

NOTE. Mark G130 red.

Make the same moves as in design at No. 34. Notice that this design is made from 2 8-harness weaves, whereas the design at No. 34 is made from 2 4-harness weaves.

PROBLEM 37.

Allover effect. Woolen and Worsted and Cotton warp.
60 threads x 60 picks.

Section A.	6 threads	6 picks	B2.
	6 ,,	3 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	9 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	18 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	15 ,,	B1.
		60	

Section B.	3 threads	6 picks	B1.
	3 ,,	3 ,,	B2.
	3 ,,	18 ,,	B1.
	3 ,,	3 ,,	B2.
	3 ,,	15 ,,	B1.
	3 ,,	6 ,,	B2.
	3 ,,	3 ,,	B1.
	3 ,,	3 ,,	B2.
	3 ,,	3 ,,	B1.
		60	

Section C.	6 threads	12 picks	B1.
	6 ,,	3 ,,	B2.
	6 ,,	15 ,,	B1.
	6 ,,	6 ,,	B2.
	6 ,,	3 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	9 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	6 ,,	B1.
		60	

Section D.	6 threads	15 picks	B1.
	6 ,,	6 ,,	B2.
	6 ,,	3 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	9 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	18 ,,	B1.
	6 ,,	3 ,,	B2.
		60	

Section E.	3 threads	12 picks	B1.
	3 ,,	3 ,,	B2.
	3 ,,	15 ,,	B1.
	3 ,,	6 ,,	B2.
	3 ,,	3 ,,	B1.
	3 ,,	3 ,,	B2.
	3 ,,	9 ,,	B1.
	3 ,,	3 ,,	B2.
	3 ,,	6 ,,	B1.
		60	

Section F.	6 threads	6 picks	B2.
	6 ,,	3 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	9 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	18 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	15 ,,	B1.
		60	

Section G.	6 threads	6 picks	B1.
	6 ,,	3 ,,	B2.
	6 ,,	18 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	15 ,,	B1.
	6 ,,	6 ,,	B2.
	6 ,,	3 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	3 ,,	B1.
		60	

Section H.	3 threads	6 picks	B2.
	3 ,,	3 ,,	B1.
	3 ,,	3 ,,	B2.
	3 ,,	9 ,,	B1.
	3 ,,	3 ,,	B2.
	3 ,,	18 ,,	B1.
	3 ,,	3 ,,	B2.
	3 ,,	15 ,,	B1.
		60	

Section I.	6 threads	15 picks	B1.
	6 ,,	6 ,,	B2.
	6 ,,	3 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	9 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	18 ,,	B1.
	6 ,,	3 ,,	B2.
		60	

Section J.	6 threads	12 picks	B1.
	6 ,,	3 ,,	B2.
	6 ,,	15 ,,	B1.
	6 ,,	6 ,,	B2.
	6 ,,	3 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	9 ,,	B1.
	6 ,,	3 ,,	B2.
	6 ,,	6 ,,	B1.
		60	

NOTE. Mark B1 red.

From the above arrangement the student should make designs, using 4, 5, and 6-harness weaves.

PROBLEM 38.

Spot effect. Woolen Cloaking and Cheviot Cape. 64 threads x 64 picks.

Section A.	8 threads	40 picks	C1.	
	8 ,,	8 ,,	C3.	4 T. L.T.
	8 ,,	4 ,,	C1.	
	8 ,,	4 ,,	C3.	4 T. L.T.
	8 ,,	8 ,,	C1.	
		64		
Section B.	8 threads	32 picks	C3.	4 T. L.T.
	8 ,,	8 ,,	C1.	
	8 ,,	8 ,,	C3.	4 T. L.T.
	8 ,,	4 ,,	C1.	
	8 ,,	4 ,,	C3.	4 T. L.T.
	8 ,,	8 ,,	C1.	
		64		
Section C.	4 threads	40 picks	C1.	
	4 ,,	8 ,,	C3.	4 T. L.T.
	4 ,,	4 ,,	C1.	
	4 ,,	4 ,,	C3.	4 T. L.T.
	4 ,,	8 ,,	C1.	
		64		
Section D.	4 threads	32 picks	C3.	4 T. L.T.
	4 ,,	8 ,,	C1.	
	4 ,,	8 ,,	C3.	4 T. L.T.
	4 ,,	4 ,,	C1.	
	4 ,,	4 ,,	C3.	4 T. L.T.
	4 ,,	8 ,,	C1.	
		64		
Section E.	8 threads	40 picks	C1.	
	8 ,,	8 ,,	C3.	4 T. L.T.
	8 ,,	4 ,,	C1.	
	8 ,,	4 ,,	C3.	4 T. L.T.
	8 ,,	8 ,,	C1.	
		64		
Section F.	8 threads	8 picks	C1.	
	8 ,,	8 ,,	C3.	4 T. L.T.
	8 ,,	4 ,,	C1.	
	8 ,,	4 ,,	C3.	4 T. L.T.
	8 ,,	40 ,,	C1.	
		64		
Section G.	8 threads	8 picks	C1.	
	8 ,,	8 ,,	C3.	4 T. L.T.
	8 ,,	4 ,,	C1.	
	8 ,,	4 ,,	C3.	4 T. L.T.
	8 ,,	8 ,,	C1.	
	8 ,,	32 ,,	C3.	4 T. L.T.
		64		
Section H.	4 threads	8 picks	C1.	
	4 ,,	8 ,,	C3.	4 T. L.T.
	4 ,,	4 ,,	C1.	
	4 ,,	4 ,,	C3.	4 T. L.T.
	4 ,,	40 ,,	C1.	
		64		

Section I.	4 threads	8 picks	C1.	
	4 ,,	8 ,,	C3.	4 T. L.T.
	4 ,,	4 ,,	C1.	
	4 ,,	4 ,,	C3.	4 T. L.T.
	4 ,,	8 ,,	C1.	
	4 ,,	32 ,,	C3.	4 T. L.T.
		64		
Section J.	8 threads	8 picks	C1.	
	8 ,,	8 ,,	C3.	4 T. L.T.
	8 ,,	4 ,,	C1.	
	8 ,,	4 ,,	C3.	4 T. L.T.
	8 ,,	40 ,,	C1.	
		64		

NOTE. Mark C3 red.

PROBLEM 39.

Stripe. Woolen and Worsted. 48 threads x 64 picks.

Section A.	4 threads	64 picks	C2.	
Section B.	2 threads	14 picks	C3.	2 T.
	2 ,,	32 ,,	C1.	3 T.
	2 ,,	18 ,,	C3.	4 T.
		64		
Section C.	4 threads	64 picks	C2.	3 T.
Section D.	2 threads	32 picks	C3.	4 T.
	2 ,,	32 ,,	C1.	3 T.
		64		
Section E.	4 threads	64 picks	C2.	
Section F.	2 threads	22 picks	C1.	
	2 ,,	32 ,,	C3.	3 T.
	2 ,,	10 ,,	C1.	3 T.
		64		
Section G.	4 threads	64 picks	C2.	3 T.
Section H.	2 threads	28 picks	C3.	3 T.
	2 ,,	32 ,,	C1.	3 T.
	2 ,,	4 ,,	C3.	3 T.
		64		
Section I.	4 threads	64 picks	C2.	
Section J.	2 threads	14 picks	C1.	
	2 ,,	32 ,,	C3.	3 T.
	2 ,,	18 ,,	C1.	3 T.
		64		
Section K.	4 threads	64 picks	C2.	3 T.
Section L.	2 threads	32 picks	C1.	3 T.
	2 ,,	32 ,,	C3.	3 T.
		64		
Section M.	4 threads	64 picks	C2.	

Section N.	2 threads	22 picks	C3.	
	2 ,,	32 ,,	C1.	3 T.
	2 ,,	10 ,,	C3.	3 T.
		64		
Section O.	4 threads	64 picks	C2.	3 T.
Section P.	2 threads	28 picks	C1.	3 T.
	2 ,,	32 ,,	C3.	3 T.
	2 ,,	4 ,,	C1.	3 T.
		64		

NOTE. Mark C3 red. Mark C1 green.

Arrangement of warp. 4 threads olive, 1 black and scarlet, 1 black and blue, 4 olive, 1 black and lavender, 1 black and yellow, 4 olive, 1 black and scarlet, 1 black and blue.

Filling. Black.

PROBLEM 40.

Stripe, Worsted. 64 threads x 16 picks.

Section A.	32 threads	16 picks	G126.	2 T. 4 P.
Section B.	32 threads	16 picks	G56.	8 T. L.T.

NOTE. Mark G56 red.

Lavender warp. Olive filling.

PROBLEM 41.

Broken Plaid. Woolen and Worsted. 64 threads x 64 picks.

Section A.	14 threads	14 picks	C2.	
	14 ,,	2 ,,	C1.	3 P.
	14 ,,	14 ,,	C2.	
	14 ,,	2 ,,	C3.	3 P.
	14 ,,	14 ,,	C2.	
	14 ,,	2 ,,	C1.	3 P.
	14 ,,	14 ,,	C2.	
	14 ,,	2 ,,	C3.	3 P.
		64		
Section B.	2 threads	32 picks	C1.	3 T.
	2 ,,	32 ,,	C3.	3 T.
		64		
Section C.	14 threads	14 picks	C2.	
	14 ,,	2 ,,	C3.	3 P.
	14 ,,	14 ,,	C2.	
	14 ,,	2 ,,	C3.	3 P.
	14 ,,	14 ,,	C2.	
	14 ,,	2 ,,	C1.	3 P.
	14 ,,	14 ,,	C2.	
	14 ,,	2 ,,	C1.	3 P.
		64		
Section D.	2 threads	16 picks	C1.	3 T.
	2 ,,	32 ,,	C3.	3 T.
	2 ,,	16 ,,	C1.	3 T.
		64		

Section E.	14 threads	14 picks	C2.	
	14 ,,	2 ,,	C3.	3 P.
	14 ,,	14 ,,	C2.	
	14 ,,	2 ,,	C1.	3 P.
	14 ,,	14 ,,	C2.	
	14 ,,	2 ,,	C3.	3 P.
	14 ,,	14 ,,	C2.	
	14 ,,	2 ,,	C1.	3 P.
		64		
Section F.	2 threads	16 picks	C3.	3 T.
	2 ,,	32 ,,	C1.	3 T.
	2 ,,	16 ,,	C3.	3 T.
		64		
Section G.	14 threads	14 picks	C2.	
	14 ,,	2 ,,	C1.	3 P.
	14 ,,	14 ,,	C2.	
	14 ,,	2 ,,	C1.	3 P.
	14 ,,	14 ,,	C2.	
	14 ,,	2 ,,	C3.	3 P.
	14 ,,	14 ,,	C2.	
	14 ,,	2 ,,	C3.	3 P.
		64		
Section H.	2 threads	32 picks	C3.	3 T.
	2 ,,	32 ,,	C1.	3 T.
		64		

NOTE. Mark C1 green. Mark C3 red.

Arrangement of warp. 14 sage, 2 black and scarlet, 14 sage, 2 black and green.

Arrangement of filling. 14 olive, 2 black and scarlet, 14 olive, 2 black and green.

TEXTILE ARITHMETIC.

The Relative "Counts" of Yarn, etc.

There have been many difficulties to confront the inquirer after the construction of textile fabrics as to the meaning of the numerous terms used in the designation of counts of yarns and the variety of those terms which represent the same meaning, and which again differ in the various sections of the country, according to the individual application thereof.

It would be a task, utterly impossible, in this small treatise to explain the great variety of systems in this country alone, never taking into consideration the "legion" that abounds in continental Europe.

Briefly the terms, cut, run, hank, count, skein, dram, grain, etc., are based upon two elementary principles, viz., weight and length, literally representing a given length of yarn for a fixed weight and *vice versa.* Unfortunately for a common understanding, the weight is movable representing certain lengths of yarn and *vice versa*, as a universal standard has not yet been adopted. Hence the universal confusion which exists between nations, countries, states and districts engaged in the same identical industry with regard to their methods of calculation. The greatest diversity, no doubt, prevails in the woolen industry. In the United States we have woolen–cut, run, grain, etc., and yet all are reducible to one common and easily understood basis. Of the advantage to be gained by the adoption of an international standard there can be but little doubt. The universal standard or system which should prevail remains a problem of the future.

A simple method would be 1000 metres as the unit of length to be called count or number, and the number of such units which weigh one K gram should be taken to represent the count or number of yarn. By this method the counts of the yarn would always show at a glance the number of metres per gram as

No. 1	= 1000 metres = 1 K g		
No. 2	= 2000 ,,	,, ,,	
No. 2½	= 2500 ,,	,, ,,	etc., etc.

The most rational method of any is that in use in the New England States, and that is, that No. 1 Yarn Woolen represents

100 yards to the ounce or 1600 yards to the lb. as the standard, and as many yards as go to make 1 ounce the yarn is designated by that number. The yarn is spoken of as so many hundred yards to the ounce. Thus:

No. 4	= 400	yards to the ounce	
No. 4½	= 450	,, ,, ,, ,,	
No. 5	= 500	,, ,, ,, ,,	
No. 5⅛	= 512.5	,, ,, ,, ,,	etc., etc.

Therefore, the standard weight is 1 ounce Avoirdupois, and the number of yards to that weight is regulated according to requirements.

Avoirdupois weight is used in measuring ordinary articles of merchandise.

Table

16 drams	=	1 oz. (ounce)
16 oz.	=	1 lb. (pound)
28 lb.	=	1 qr. (quarter)
4 qr.	=	1 cwt. (hundredweight)
20 cwt.	=	1 ton (long ton)

Note 1. The long ton is used in the United States custom-houses and the mining districts, in weighing coal and iron, but for other commodities the ton of 2000 lbs. or short-ton is used.

Note 2. The relation of Avoirdupois weight to Troy weight may be seen by comparing the following table with the Troy table.

$\frac{1}{16}$ of 7000 grains = 437½ grains = 1 oz. Av.
$\frac{1}{16}$ of 437½ ,, = $27\frac{11}{32}$,, = 1 dram Av.

Note 3. 62½ lbs. Avoirdupois = 1000 oz. the weight of a cubic foot of distilled water.

Troy Weight.

24 gr.	=	1 pennyweight (pwt.)
20 pwt.	=	1 oz.
12 oz.	=	1 lb.

Note 4. The Troy pound is little used, gold and silver bullion are sold by the ounce; gold ornaments by the pennyweight.

Comparison of Weights.

1 lb. Troy = $\frac{5760}{7000}$ = $\frac{144}{175}$ of 1 lb. Avoirdupois
1 oz. Troy = $\frac{480}{437.5}$ = $\frac{192}{175}$ of 1 oz. Avoirdupois

Exercise 1. How many ounces in 8 lb. 7 oz. Av.? in 37 lb. 13 oz.? in 548 lbs. 15 oz.? in ¾ of 1 lb.? in ⅝ of 1 T.? in .325 of a long ton?

Exercise 2. How many grains in 2 lbs. 5 oz.? in $\frac{11}{12}$ of 1 lb.? in .0875 of 1 lb?

Exercise 3. Change the following simple numbers to compound numbers. 568 oz. Av. 2825 gr. Troy; 7437.5 oz. Av.

Exercise 4. What is the cost of 2 tons of woolen waste at 3½ cents a pound?

Exercise 5. 2 lbs. 12 oz is what part of 1 T? 12 oz. is what part of a ton?

Table of Relative counts of Yarn.

Woolen No. 1 run	=	1600	yards	per	lb.	Av.,	standard	No.
,, No. 1 cut	=	300	,,	,,	,,	,,	,,	,,
,, No. 1 skein	=	256	,,	,,	,,	,,	,,	,,
Worsted No. 1 count	=	560	,,	,,	,,	,,	,,	,,
Cotton No. 1 count	=	840	,,	,,	,,	,,	,,	,,
Linen No. 1 lea	=	300	,,	,,	,,	,,	,,	,,
Spun silk No. 1 count	=	840	,,	,,	,,	,,	,,	,,

Such fibres as linen, jute, hemp and ramie fibre are usually figured by the lea of 300 yards to the lb. Av. In the Grain System the weight in "grains" which 20 yards weigh designates the counts.

Thus if 20 yards weigh 20, 25 or 30 grains the counts would be Nos. 20, 25 or 30 grain yarn respectively.

Silk Counts.

Spun silk (a term given to silk that has been remanufactured or respun) is based upon the same system as cotton, viz. hank of 840 yards, and the number of such hanks which weigh 1 lb. denote the counts.

Dram silk. The system adopted in the United States for specifying the size of silk is based on the weight in drams (Av.) of a skein containing 1000 yards, a skein, thus weighing 5 drams, is technically called 5 dram silk. The number of yards of 1 dram silk to a pound must accordingly be 16 x 16 x 1000 or 256000. (See Avoirdupois table.)

Dram silk is based upon 20.000 yards per oz.

Worsted Counts.

(LENGTH AND WEIGHT TABLES.)

This system is based upon the hank of 560 yards and the number of such hanks which weigh 1 lb. equal the counts.

No. 1 =	560	yards	in	1 lb.	
2 =	1120	,,	,,	1 lb.	
3 =	1680	,,	,,	1 lb.	etc., etc.

Cotton Counts.

Cotton is based upon the hank of 840 yards and the number of such hanks which weigh 1 lb. denote the counts. The following tables are used when dealing with cotton calculations.

Table of lengths for cotton.

1½	yards =	the circumference of reel, or 1 wrap
120	yards =	1 lea, or 80 wraps of the reel
840	yards =	7 leas, or 1 hank

No. 1 cotton =	840 yards in 1 lb.		
2 ,, =	1680 ,, ,, 1 lb.		
3 ,, =	2520 ,, ,, 1 lb.		etc., etc.

Linen and other like fabrics, such as jute, hemp, ramie fibre and China grass are based upon the lea of 300 yards, and the number of such leas which weigh 1 lb. represents the counts.

No. 1 = 300 yards to the lb.
2 = 600 ,, ,, ,, ,,
3 = 900 ,, ,, ,, ,, etc., etc.

English Woolen or Skein System.

This system is based upon the skein of 256 yards, and the number of such skeins which weigh 1 lb. equals the counts. In England the yarn is spoken of as so many yards to the dram, or so many skeins, which is the same thing when referring to its thickness. Thus: 6 skeins or 6 yards, to the dram 10 skeins or 10 yards to the dram.

No. 1 = 256 yards to the lb.
2 = 512 ,, ,, ,, ,,
3 = 768 ,, ,, ,, ,,

The standard weight is 1 dram Avoirdupois, and the number of yards to that weight is regulated according to requirements.

Philadelphia or the cut system is based upon the hank of 300 yards, and the number of such hanks which weigh 1 lb. represent the counts.

No. 1 = 300 yards to the lb.
2 = 600 ,, ,, ,, ,,
3 = 900 ,, ,, ,, ,,

When dealing with yarns from England and Scotland each rural district has its individual nomenclature for designating the counts: Galashiels 300 yds. in 24 oz. Hawick 300 yds. in 26 ozs. West of England 20 yds. in 1 oz. Yorkshire skein 1536 yds. in 1 wartern (which equals 6 lbs.) Halifax the number of drams 80 yards weigh.

Exercise 6. How many yards of yarn in 1 lb. each No. 23 cotton, No. 5 run woolen, No. 32 worsted, No. 22 lea linen, No. 25 spun silk?

Exercise 7. What will be the counts of the following yarns: 12600 yards cotton = 1 lb. 11200 yards worsted = 1 lb. 12000 yards linen = 1 lb. 13440 yards spun silk = 1 lb.

Exercise 8. How many yards per lb. of silk thread are there in No. 4 dram silk, No. 5 dram silk, No. 3 dram silk?

Exercise 9. Woolen grain system. How many yards per lb. are there in No. 7 grain woolen and No. 5 grain woolen?

Exercise 10. If 16800 yards of yarn weigh 1 lb. what counts would represent this length and weight in worsted, cotton and woolen?

Exercise 11. The weight of 1680 yards of worsted is 3 oz. What is the counts?

Exercise 12. Find the respective weights of 800 yards, 4200 yards and 6300 yards, of (*a*) 4-run woolen, (*b*) No. 30 worsted, (*c*) No. 30 cotton.

Rule 1. To find the yards in 1 lb. of any given counts of woolen run, woolen cut, worsted, cotten, linen and spun silk, multiply the standard number by the given counts.

Example. How many yards in No. 15 cotton, 3-run woolen, 20 worsted? No. 15 cotton, 840 x 15 = 12600 yds. 3-run woolen 1600 x 3 = 4800 yds. No. 20 worsted, 560 x 20 = 11200 yds.

Exercise 13. How many yards in 18 lea linen, No. 40 spun silk, No. 35 cotton?

Rule 2. To find the weight of any number of yards of a given count the number of yards being given. Divide the given number of yards by the counts x the standard number.

Example. What is the weight of 107520 yards of No. 32 cotton?

$$\frac{\overset{\overset{4}{\cancel{3360}}}{\cancel{107520}}}{\cancel{32} \times \cancel{840}} = 4 \text{ lbs., Ans.}$$

Exercise 14. Find the weight respectively of 12400 yards of 30 worsted, 11960 yards of 20 lea linen and 7200 yards of 4½-run woolen.

It is often necessary to require the weight in ounces of a small number of yards.

Rule 3. Multiply the given number of yards by 16 and divide by the counts x the standard number.

Example. What is the weight in ounces of 2800 yards of No. 20 worsted?

$$\frac{\overset{\overset{4}{\cancel{140}}}{\cancel{2800}} \times \cancel{16}}{\cancel{20} \times \underset{35}{\cancel{560}}} = 4 \text{ oz., Ans.}$$

Exercise 15. What is the weight of 4.200 yds. of 30 cotton, 3600 yards of 32 worsted, 1850 yards of 2 ½ run woolen?

The woolen run system is the most simple of all textile yarn calculations, as 100 yds. per oz. = No. 1 run.

Rule 4. To find the weight in ounces of a given number of woolen run yarn. Add two ciphers to the counts and divide into the given number of threads.

Example. What is the weight of 2700 yds. of 2 run woolen?

$$\frac{\overset{13.5}{27\cancel{0}\cancel{0}}}{2\cancel{0}\cancel{0}} = 13.5 \text{ oz., Ans.}$$

Exercise 16. What will 1840 yds. of 3¼-run, 2100 yds. of 4½-run, 3640 yds. of 3½-run woolen weigh respectively?

Rule 5. Grain System. To find the counts of a woolen thread the number of yards and weight being known. (The weight in grains which 20 yds. weigh designates the count)

Multiply the given weight by grains in 1 lb. x 20 yards, divide by the given number of yards of yarn.

What is the counts of 28000 yds. which weigh 4 lbs?

$$\frac{\cancel{4} \times \cancel{7}\cancel{0}\cancel{0}\cancel{0} \times 20}{\underset{\cancel{7}\cancel{0}\cancel{0}\cancel{0}}{\cancel{2}\cancel{8}\cancel{0}\cancel{0}\cancel{0}}} = 20 \text{ grains per 20 yards. 20s counts, Ans.}$$

Exercise 17. Find the counts of these yarns: 14000 yds. weigh 3½ lbs., 37620 yds. weigh 4¼ lbs., 29640 yds. weigh 4 lbs.

Metric Tables and Measurements.

Linear Measure.	Weights.
10 m m = 1 c m	10 m g = 1 c g
10 c m = 1 d m	10 c g = 1 d g
10 d m = 1 M	10 d g = 1 g
10 M = 1 d m	10 g = 1 D g
10 D m = 1 H m	10 D g = 1 H g
10 H m = 1 K m	10 H g = 1 K g

The Continental method for worsted is based upon 1000 metres per kilogram, *e. g.*, No. 1 counts contains 1000 x 1 metres. No. 2 counts contains 1000 x 2 metres. No. 3 counts contains 1000 x 3 metres. etc. etc.

Table of Equivalents.

1 d m	= 3.937 inches
1 oz.	= 28.35 grams
1 oz.	= 437.5 grains
1 gram	= 15.432 grains
1 K g	= 2.2046 lbs. or 15,432.2 grains
1 M	= 1.094 yards
1 M	= 39.37 inches
1000 M	= 1 Kg or 2.2046 lbs. worsted yarn
1000 M	= 1094 yards

Exercise 18. (*a*) What is a d m; (*b*) what is its equivalent in inches; (*c*) how many square inches in one square d m; (*d*) how many grams in 1 oz; (*e*) how many grains in 1 g; (*f*) how many lbs. in 1 k g; (*g*) how many yards in 1 metre; (*h*) how many inches in 1 metre; (*i*) how many yards in 1 k m?

Exercise 19. How many metrics of No. 7 metric worsted in 1 K g, 7 H g, 1 D g and 9 gms?

Exercise 20. What is the weight in gms of 439 metres of No. 5.5 metric worsted?

Exercise 21. What is the difference in length of 7.25 H g of No. 3.25 metric worsted and 5 D g of No. 6.875 metric worsted.

In the metric system woolen counts are based on the same principle as worsted counts, that is, 1000 gms. The same holds true with cotton, linen, silk, jute, etc.

It will be seen from this that the metric system possesses a great advantage over the many varied systems now in use, inasmuch that it is simpler in calculations, decimals doing away with the more complicated fractions of the so-called English system, (such as $\frac{5}{8}$, $\frac{13}{16}$, $\frac{27}{32}$ or $\frac{39}{64}$) etc., and the uniformity of difference between K g, H g, D g and so on rather than the complex system of tons, hundredweights, pounds, ounces, drams and grains.

To reduce from K g to grains in the metric it is only necessary to multiply the given number by 1000, while to reduce from lbs. to drams in English the given number must be multiplied by 16 x 16. With metric numbers the difference may be easily computed. Taking 2.25 K g of yarn and wishing to find the weight in grams, the following simple process is all that is required:

$$2.25 \times 1000 = 2250 \text{ grams.}$$

This weight approximately represents 4 lb., 8 oz. and wishing to find the weight in drams the following complicated equation is necessary:

$$4.8 \text{ oz.} \times 16 \times 16 = \text{drams.}$$

Then again a No. 1 in the English system equals 1600 yds. woolen, 560 yds. worsted, 840 yds. cotton, 300 yds. linen, and so on to the lb., while in the metric system a No. 1 count represents 1000 metres to the K g in each and every variety of yarn, giving a simple basis of comparison between the yarns.

The Continental system of numbering thrown silk is based upon the hank of 400 French ells. The skein or hank is 476 metres, or 520 yards, and the weight of this hank in deniers represents the counts.

533.33 deniers equal 1 oz.

If 1 hank of the above length weighs 10 deniers, the counts equal No. 10 denier.

Approximately No. 1 denier = $533\frac{1}{3} \times 520 = 277,332$ yards per oz.
$533\frac{1}{3} \times 520 \div 40 = 6933\frac{1}{3}$ yards per oz. No. 40 denier
$533\frac{1}{3} \times 520 \div 60 = 4622\frac{2}{3}$,, ,, ,, No. 60 denier

To Change the Counts of Yarns.

The three great industries, Woolen, Worsted, and Cotton, are becoming more and more amalgamated in their applications. There are goods composed of woolen filling and cotton warps; worsted filling and cotton warps; woolen and worsted filling combined with cotton warps; and also woolen and worsted warps combined with cotton and woolen fillings; so that it is important that the calculations pertaining to each should be well understood. The line of the calculations in this work has been directed towards these requirements. There may be shorter methods of calculation which may be used by those fully conversant with the different particulars concerning textile manufactures, but it matters little what the system may be, if only simple and reliable.

Changing the counts of one system of yarn into the equivalent of another system of yarn.

Rule 6. To change cotton counts into woolen runs. Multiply 840 by the known cotton counts and divide by 1600, the standard of yards equaling No. 1 run, woolen.

Exercise 22. What will be the size of a woolen thread equivalent to a No. 20's cotton?

Rule 7. To change cotton counts into worsted counts. Multiply 840 by the known cotton counts and divide by 560, the standard of yards equaling No. 1 worsted counts.

Exercise 23. What will be the equivalent in a worsted thread to a No. 30's cotton?

Rule 8. To change woolen runs into worsted counts. Multiply 1600 by the known woolen runs and divide by 560, the standard of yards equaling No. 1 worsted counts.

Exercise 24. What will be the equivalent in a worsted thread to a 7-run woolen?

Rule 9. To change woolen runs, worsted counts, and cotton counts into their equivalents in linen and Philadelphia counts. Multiply by the woolen, worsted, or cotton standard and divide by 300, the standard of yards equaling No. 1 lea linen and No. 1 cut woolen.

Exercise 25. What will be the equivalent in a linen thread to a 3-run woolen, No. 20 worsted and No. 24 cotton?

Grain System.

Rule 10. To change woolen, worsted, linen, and cotton counts to their equivalents in the grain system. Multiply 7000 grains by 20, the yards representing the grain standard, and divide by the standard of the other yarns.

Example. What will be the equivalent in the grain system to a number of 20's cotton?

$$\frac{7000 \times \cancel{20}}{\cancel{20} \times 840} = 8.33 \text{ counts}$$

Exercise 26. What will be the equivalent in the grain system of the following yarns: No. 24 worsted, 4-run woolen, 16 lea linen?

Dram System.

Rule 11. To change woolen, worsted, linen, and cotton counts to their equivalents in the dram system. Multiply the given weight by drams per lb. x the yards in 1 dram, divided by the given length of yarn.

What will be the equivalent in the dram system to No. 30 cotton?

$$\frac{1 \times 256 \times 1000}{30 \times 840}$$

Exercise 27. Find the equivalent in the dram system to No. 24 cotton, $4\frac{1}{4}$-run woolen, 30 worsted.

Denier System.

Rule 12. To change woolen, worsted, linen and cotton counts to their equivalents in the denier system. Multiply the yards in 1 hank (520) x deniers in 1 oz. ($533\frac{1}{3}$) x ounces (16) in 1 lb., divided by the length in 1 lb. of the known counts.

Exercise 28. What will be the equivalent in the denier system to a No. 30 worsted?

Metric System.

Rule 13. The number of metres in 1 kilogram (1000), multiplied by the number of inches (39.37) in 1 metre, will give the

total inches. This, divided by the inches (36) in 1 yard, will give the total yards, and again divided by the weight of 1 K m x the standard number will give the English counts, or constant.

SOLUTION

$$\frac{1000 \times 39.37}{36 \times 560 \times 2.205} = .885 \text{ worsted constant}$$

$$\frac{1000 \times 39.37}{36.840 \times 2.205} = .590 \text{ cotton and spun silk}$$

$$\frac{1000 \times 39.37}{36 \times 1600 \times 2.205} = .3099 \text{ woolen, say } .31$$

$$\frac{1000 \times 39.37}{36 \times 300 \times 2.205} = 1.653 \text{ linen, and woolen cut}$$

The English	.885	is equal to a	No.	1	Metric	worsted
,,	.590	,, ,,	,, ,,	1	,,	cotton or spun silk
,,	.310	,, ,,	,, ,,	1	,,	woolen
,,	1.653	,, ,,	,, ,,	1	,,	linen, etc., etc.

PROOF 1 metre = 1.094 yards. 1 kilogram = 2.205 lbs.
1000 metres No. 1 = 1 kilogram = 2.205 lbs.
1000 metres = 1094 yards

1094 ÷ 2.205 = 496.1 yards per lb.
496.1 ÷ 560 = .885 worsted constant
496.1 ÷ 840 = .590 cotton ,,
496.1 ÷ 1600 = .310 woolen ,,
496.1 ÷ 300 = 1.653 linen ,,

Rule 14. The English count, divided by the constant, will give the metric count.

English 20 cotton ÷ .590 = 33.89 Metric cotton

Exercise 29. Find the metric counts of 24 worsted, 6 run woolen, 18 linen.

Rule 15. The metric count, multiplied by the constant, will give the English count.

.310 x 20 Metric woolen = 6.2 English run woolen

Exercise 30. Find the counts in English of 23.6 cotton, 28.2 worsted, 16 woolen, metric.

Twisted, Ply, and Compound Yarns.

Yarns spun from different fibres and different denominations are frequently twisted together for decorative purposes as well as for strength, *e. g.*, silk to cotton, worsted to woolen, etc., etc., and also since yarns spun in one country and consigned for use in other countries and localities where a different system of num-

bering of yarn is adopted, it becomes necessary to change any given number into an equivalent count of some other required denomination.

Two-Ply Yarns.

Worsted and cotton yarns are usually numbered according to the count of the single yarn, with the number of ply, threads, or folds put on the left or before it.

Thus 2/40 or 2-40's yarn indicate that the yarn is composed of two other threads of No. 40's single, making a twofold or two-ply yarn of 20 hanks to the lb., and must be taken as representing 20 times 840 yds. cotton yarn to the lb., but when written as 40's or 1/40 it represents 40 hanks, or 40 x 840 yds. to the lb.

Spun silk yarns are generally two or more ply, and the number of the yarn always indicates the number of hanks in 1 lb. The number of ply is usually written after the hanks per lb. Thus 60/2 or 60's-2 spun silk indicates that the yarn is 60 hanks to the lb. composed of two threads of other counts.

Exercise 31. Find the respective weights of 6 yds., 30 yds., 150 yds., 1120 yds., 3600 yds. (*a*) woolen run 3-run, (*b*) 4 grain woolen, (*c*) No. 12 woolen cut, (*d*) No. 20 worsted, (*e*) No. 24 cotton.

Exercise 32. The weight of a length of No. 32 worsted yarn is 2 oz., what is its length?

Exercise 33. If 320 hanks of worsted weigh 12 lbs. what are the counts?

Exercise 34. Change the following into cotton counts: 80/2 silk, 2/60 worsted, No. 10 grain woolen, No. 40 linen.

Exercise 35. If 22,400 yds. of yarn weigh 1 lb., what counts would represent this weight and length in cotton, woolen run, worsted, linen, and grain woolen?

Woolen yarns are usually designated double and twist yarns. Thus, 6 run black and white D. & T. would mean that 1 thread black 6 run and 1 thread white 6 run has been doubled and twisted representing a thread equivalent to a 3-run—the take up.

From the foregoing it will be readily perceived that whenever a certain length of yarn is given together with its weight (or other data sufficient to obtain these two important factors) the counts of yarn in any other denomination can easily be found.

Given a length of 67,200 yds. of yarn, the weight is 6 lbs., what is the count of the yarn in worsted?

Then $67{,}200 \div 6 = 11{,}200$ yards per lb.

$11{,}200 \div 560 =$ No. 20 worsted counts

Exercise 36. Find the equivalent counts in 2/60 worsted in cotton, linen, spun silk metric and woolen grain systems.

Exercise 37. Convert the following into metric counts: No. 36 worsted, 4½-run woolen, 50 lea linen, 25 cotton, and No. 60 woolen grain.

Exercise 38. What is the difference in principle of counting yarns in the woolen run denominations and the woolen grain system?

Exercise 39. What is the equivalent counts in worsted of (*a*) No. 21 metric yarn and (*b*) in metric of No. 16 worsted yarn?

Exercise 40. What is the difference in designation of two or more ply spun silk yarn as compared with two or more ply cotton, worsted, linen, or woolen?

Exercise 41. If 280 yds. of silk yarn weigh 13¾ drams, what counts in worsted would represent this weight and length?

Exercise 42. What is the equivalent count of No. 35 English worsted in metric counts?

Exercise 43. Find the denier counts of No. 1000 (yds. per oz.) tram silk.

Three and More Ply Twists.

When two or more single threads are twisted or folded together the result is a heavier yarn. It is necessary then to find the number of hanks or skeins per lb. of the combined thread, but it must be understood that two threads 20 yards long when twisted together will be much shorter than the original two threads. This can be proved by twisting two threads together of a given length, weighing them, and again measuring the twisted thread, and then again obtaining two threads of the original yarn of the exact length of the twisted yarn and comparing their weights, This process is known as finding the equivalent or resultant counts.

Ply yarns composed of threads of equal counts. The new count is found by dividing the given counts by the number of ply or threads twisted together, 2-ply 60's = No. 30, written 2/60 or 2-60; 3-ply 60 = 20, written 3/60 or 3-60; 4-ply 60 = 15, written 4/60 or 4-60.

Supposing there is no variations in the take up of the size and length of each yarn during twisting, equal length of each material will be required.

It very often occurs in fancy novelty yarns that threads of unequal thickness are twisted together. If a No. 60 thread and a

No. 40 thread are twisted together, the count of the doubled thread will not be the same as if two threads of No. 50 has been twisted.

For the purpose of illustrating: When 60 hanks of 60 worsted are used, 60 hanks of 40 worsted will also be used, and when these have been twisted together we shall have only 60 hanks; but 60 hanks of the former count weigh 1 lb., while 60 hanks of the latter 1½ lbs., consequently the 60 hanks of twisted threads equal 2.5 lbs.

The above may be stated thus:—

Rule 16. The product of the given counts, divided by their sum, equal the new count of twisted yarn.

$$\frac{60 \times 40}{60 \quad 40} = \frac{2400}{100} = \text{No. } 24$$

Some allowance must be made for take up or contraction in twisting, but this will vary with the number of turns per inch in the yarn, and the diameter of the threads is a factor that must be considered when figuring for shrinkages.

Take up, contraction and shrinkages will not be taken into account in these examples.

Rule 17. When three or more unequal threads are twisted together, the counts of the resulting twist thread may be found by selecting the highest count and divide it by itself and each of the given counts; the quotient in each case will then represent the relative weight of each thread in lbs.; then divide the highest count by the sum of the quotients, and the answer will equal the new count.

Example. Find the counts of a 3-ply thread composed of one thread each of 20's, 30's, and 60's cotton.

$$\begin{array}{l} 60 \div 60 = 1 \\ 60 \div 30 = 2 \\ 60 \div 20 = 3 \\ \hline \qquad\qquad 6 \end{array} \qquad 60 \div 6 = \text{No. 10's new count}$$

Exercise 44. Find the counts of a 3-ply thread composed of one thread each of 24's, 32's, and 30's worsted.

It is obvious that when threads are twisted together composed of different materials it will be necessary to first reduce all to the denomination of the yarn system in which it is required.

Suppose a compound twist thread is made up of 1 thread of 24's black worsted, 1 thread of 16 red cotton, and 1 thread 8 green cotton. Find the equivalent counts in worsted.

$$840 \times 16 = 13440 \div 560 = 24 \text{ worsted}$$
$$840 \times 8 = 6720 \div 560 = 12 \quad ,,$$

$$\begin{array}{l} 24 \div 24 = 1 \\ 24 \div 24 = 1 \\ 24 \div 12 = \underline{2} \\ \qquad\qquad\quad 4 \end{array} \qquad 24 \div 4 = 6$$

What would be equal in a single woolen thread to a 3-ply yarn composed of No. 10.5-run woolen, No. 20's cotton, and No. 30's worsted?

$$840 \times 20 = 16800 \div 1600 \quad 10.5$$
$$560 \times 30 = 1680 \div 1600 \quad 10.5$$
$$10.5 \div 3 = \text{No. } 3.5 \text{ run woolen}$$

Exercise 45. If a thread of 20's and a thread of 40's single worsted be twisted together what will be the resultant counts?

Exercise 46. What would be the resultant counts of (*a*) 30's and 60's cotton twisted together, (*b*) of 30's and 60's linen twisted together, and (*c*) of 30's and 60's worsted twisted together?

Exercise 47. A 3-ply thread is made by twisting the following yarns: 1 thread 10½-run woolen, 1 thread 30's worsted, 1 thread 20's cotton. What would be the equivalent counts of the compound thread in (*a*) single cotton, (*b*) woolen cut, (*c*) a single worsted, and (*d*) a woolen run.

Exercise 48. Give the resulting counts of 36's, 45's, and 54's worsted yarn twisted together.

Exercise 49. How many hanks would there be in 1 lb. of 2-ply yarn made by twisting 1 thread of 32's cotton and 1 thread 44's cotton together?

Exercise 50. Given 36 metric cotton count, find the equivalent counts when twisted with a 60/2 spun silk, the answer to be in American cotton counts.

Exercise 51. What would be the resulting counts in spun silk of 30's worsted and 20/2 spun silk twisted together?

Exercise 52. Find the equivalent counts of 20's, 32's, and 50's worsted twisted together.

Exercise 53. A thread is composed of 2 threads 40's worsted and 1 thread 80/2 spun silk. Find the equivalent counts in cotton.

Exercise 54. Find the resulting counts of 70's, 60's, 40's, and 20's cotton twisted together.

Exercise 55. Twist together a 2/100 metric cotton with a No. 78 American cotton count. Find the equivalent count in American worsted.

Exercise 56. Find the resulting count of No. 50's and No. 70 metric worsted twisted with No. 30 and No. 40 American spun silk.

Exercise 57. How many yards in 1 lb. hank of English cotton of the twist composed of No. 50 and No. 70 metric cotton?

Fancy and Novelty Yarns.

Novelty yarns, such as Knop, Spiral, Loop, Corkscrew, Chain, etc., are made from various lengths of thread, and consequently the previous rules in all cases will not apply. If there is no variation in lengths the same number of hanks will be required of each kind of yarn, but when lengths vary the counts of the twisted threads will also vary according to the several modifications of take up in the material used.

If, for example, we wish to make a fancy yarn from three different counts of yarn, say No. 40's, No. 30's, and No. 20's cotton, the take up in each case being equal, what length and weight of each material is necessary?

Rule 18. First find the necessary number of lbs. of each yarn to give equal length (without take up), select the highest count from one of the given counts, divide this highest count by the count of each of the others, and the result will equal the relative weight required of each.

$$\text{(A)} \quad \begin{array}{l} 40 \div 40 = 1 \text{ lb.} \\ 40 \div 30 = 1\frac{1}{3} \\ 40 \div 20 = 2 \end{array}$$

The respective weights of the yarn, multiplied by their counts, will give the required number of hanks of each.

$$\text{(B)} \quad \begin{array}{lll} 1 \text{ lb.} & \times\ 40 = 40 & \text{hanks} \\ 1\frac{1}{3} & \times\ 30 = 40 & ,, \\ 2 & \times\ 20 = 40 & ,, \end{array}$$

All this is obvious, that is, if we require a certain length of twist the yarns must be of the same length whatever the counts; but when the take up varies the conditions are more or less complicated.

A novelty yarn is made by twisting 2 threads of No. 40 red cotton, 1 thread of No. 30 green cotton, and 1 thread No. 20 black cotton, and the relative lengths of material used are 7 in., 5 in., and 4 in. respectively. Find the count of the combined thread. The last thread is straight, or 100%.

First, find the take up of each yarn by dividing each relative length by the straight or 100% thread.

	No. 40's = 7 ÷ 4 = $1\frac{3}{4}$	take up
(C)	30 = 5 ÷ 4 = $1\frac{1}{4}$	,, ,,
	20 = 4 ÷ 4 = 1	,, ,,

The number of hanks of each (obtained by rule A and B), multiplied by take up (obtained by rule C), will give the number of hanks of the respective yarns necessary for the twist yarn.

40 x $1\frac{3}{4}$ = 70 hanks of No. 40
40 x $1\frac{3}{4}$ = 70 ,, ,, No. 40
40 x $1\frac{1}{4}$ = 50 ,, ,, No. 30
40 x 1 = 40 ,, ,, No. 20

And these, divided by their relative counts, will give the weight of each.

70 hanks ÷ 40 = 1.75 lbs.
70 ,, ÷ 40 = 1.75 ,,
50 ,, ÷ 30 = 1.66 ,,
40 ,, ÷ 20 = 2.00 ,,

7.16 ,,

The number of hanks necessary for equal length, divided by the sum of their weights, will give the count of the combined or resultant thread.

40 ÷ 7.16 = 5.58 count.

To prove, find the length of each yarn in one hank of the novelty yarn thus:

7 in. No. 40's = 840 x $1\frac{3}{4}$ = 1470 yards
7 in. No. 40 = 840 x $1\frac{3}{4}$ = 1470 ,,
5 in. No. 30 = 840 x $1\frac{1}{4}$ = 1050 ,,
4 in. No. 20 = 840 x 1 = 840 ,,

The weight of each being

No. 40 = 1470 x 7000 ÷ 40 x 840 = 306.25 grs.
40 = 1470 x 7000 ÷ 40 x 840 = 306.25 ,,
30 = 1050 x 7000 ÷ 30 x 840 = 291.66 ,,
20 = 840 x 7000 ÷ 20 x 840 = 350.00 ,,

1254.16 ,,

If, therefore, 1 hank of novelty yarn weighs 1254.16 the counts will be 7000 ÷ 1254.16 = 5.58 counts, the same count as given in the above example.

Exercise 58. A loop yarn is composed of 2 threads of 2/32 white cotton and 1 thread of 24's red worsted; 2 yards of worsted are used to each yard used of 2/32 cotton. Find how many hanks per lb. in worsted counts of the loop or compound thread.

Exercise 59. A novelty yarn is made up of 2 threads 2/80 white cotton, 2 threads 1/40 red cotton, and 2 threads of 2/100 black cotton, the relative lengths of material used being 8 in., 9 in., and 4 in., respectively. The 4 in. thread is the finished length. Find the count of the compound thread.

Exercise 60. A loop yarn is composed of 2 threads of No. 24's lustre worsted, 1 thread of 2/40 red cotton, and 1 thread No. 8's green cotton. The relative lengths of material used are 24 in., 12 in., and 10 in., respectively, and these produce 9 ins. of finished loop yarn. Find the resultant counts in cotton.

Exercise 61. A novelty yarn is made up of 2 threads No. 2/48's, 2 threads 1/35's, and 2 threads 2/60 all metric cotton. The relative lengths of material used are 15 c m, 1 d m, and 8 c m, respectively, and these produce 7 c m of loop yarn. Find the resultant counts in American cotton system.

Average Counts.

When average counts are required, it is assumed that the threads are contiguous in the woven fabric and retain their respective individualities, *e. g.*, when two or more threads of various sizes are used side by side in the same fabric, it is frequently necessary and advantageous to determine the average counts of these threads, that is, the count of the threads which will represent the same weight and length for the combined number of several yarns employed in the given woven fabric. Suppose a cloth is woven with yarn of the same material but with yarn of different counts, *e. g.*, a cloth is woven with 2 threads of 60's cotton and 1 thread of 20's cotton. What is the average count?

Rule 19. Multiply the high count by the number of threads of each count in one repeat of the pattern.

60 x 2 = 120 hanks
60 x 1 = 60 ,,

Divide each product separately by the given counts

120 ÷ 60 = 2 lbs
60 ÷ 20 = 3 ,,
180 5 ,,

Divide sum of these quotients into the total number of hanks

180 ÷ 5 = 36 average counts

The answer equals the average counts.

Rule 20. To find the average counts when any number of threads of different counts are used in the same cloth. Divide the product of their counts by the sum of the unequal counts, then multiply by the number of threads in one repeat of the pattern. The answer equals the average counts.

A sample is composed of 1 thread of black No. 16's cotton and 1 thread of white No. 40's cotton. Find the average counts. First method.

$$\begin{array}{l} 40 \times 1 = 40 \\ 40 \times 1 = 40 \\ \hline \qquad\quad\;\; 80 \end{array}$$

$$\begin{array}{l} 40 \div 40 = 1. \\ 40 \div 16 = 2.5 \\ \hline 80 \qquad\quad 3.5 \end{array}$$

$80 \div 36 = 22.85$ average counts

Second method.

$$\frac{40 \times 16}{16 + 40} = \frac{640}{56} = 11\tfrac{3}{7} \text{ 2-ply yarn}$$

This represents when the threads are made into a compound thread, and if made from equal counts of yarn, the average would be 22 6/7.

The threads are laid side by side in the pattern and each one retains its individuality, therefore, the average weight of the threads is half of the compound thread or double the counts.

A pattern is composed of 2 threads black cotton No. 40's and 1 thread red No. 16 cotton. Find the average counts.

$$\begin{array}{l} 40 \times 2 = 80 \\ 40 \times 1 = 40 \\ \hline \qquad\quad 120 \end{array}$$

$$\begin{array}{l} 80 \div 40 = 2. \\ 40 \div 16 = 2.5 \\ \hline \qquad\qquad 4.5 \end{array}$$

$120 \div 4.5 = 26.66$ average

$$\begin{array}{l} 40 \div 40 = 1.0 \\ 40 \div 40 = 1.0 \\ 40 \div 16 = 2.5 \\ \hline \qquad\qquad 4.5 \end{array}$$

$40 \div 4.5 = 8.88 \times 3 = 26.64$ average.

A pattern is composed of 4 threads of white No. 80 cotton, 2 tereads black No. 40 cotton and 1 thread red No. 16 cotton. Find the average counts.

$$
\begin{array}{llll}
80 \div 80 = 1 \text{ x } 4 & \text{threads} & = 4 \\
80 \div 40 = 2 \text{ x } 2 & \text{,,} & = 4 \\
80 \div 16 = 5 \text{ x } 1 & \text{,,} & = 5 \\
\hline
\qquad\qquad\quad 7 & & 13
\end{array}
$$

$$\frac{80 \text{ x } 7}{13} = \frac{560}{13} = 43\tfrac{1}{13} \text{ average counts.}$$

Proof. Find the weight of hank of each count given, then find the weight of an average hank with the threads in the proportion given, then find what would be the counts of that weight.

1 hank of 80's = 7000 ÷ 80 = 87.5 grains.
1 ,, ,, 40's = 7000 ÷ 40 = 175.0 ,,
1 ,, ,, 16's = 7000 ÷ 16 = 437.5 ,,

80 = 87.5 x 4 = 350.0 grains.
40 = 175.0 x 2 = 350.0 ,,
16 = 437.5 x 1 = 437.5 ,,
1137.5

1137.5 ÷ 7 = 162.5 grains average.
7000 grs. ÷ 162.5 = $43\frac{1}{13}$ average counts.

Exercise 62. A pattern is composed of 4 threads of 80's black worsted, 3 of 60 white and 1 of 16's blue worsted. Find the average count.

Exercise 63. Find the average counts of a cloth made alternately with 1 thread 16's and 1 thread 32's worsted.

Exercise 64. A cloth is woven with 1 pick No. 24's worsted and 1 pick No. 24's cotton. What is the average count in woolen?

Unknown Count in a Compound or Twist Thread.

Occasionally it happens that a manufacturer or spinner has given to him the counts of a novelty or fancy twist yarn, also one or more of the threads which go towards its composition. It then becomes necessary to find the size of the unknown thread which, together with the counts, make the required compound twist yarn.

To find the required counts of a single yarn to be twisted with another, the counts of which is already known to produce a compound or twist thread of a known count.

Rule 21. Multiply the counts of the known single thread by the counts of the compound or twist thread and divide the product by the known single thread minus the known counts of the compound thread. The quotient will be the counts of the required single thread.

Example: Having some yarn in stock, the counts of which is 1/30 cotton, and wishing to produce a compound or twist thread equal to a 1/12 cotton. Find the count of the required thread.

$$\frac{30 \times 12}{30 - 12} = \frac{360}{18} = \text{20's required thread.}$$

$$\text{Proof } \frac{30 \times 20}{30 + 20} = \frac{600}{50} = \text{12 twist or compound thread.}$$

Exercise 65. Having 40's cotton yarn and wishing to twist it with another yarn to make it equal to 24's. Find count of required thread.

Exercise 66. What counts should be twisted with 20's worsted to make it equal to No. 12's cotton?

Exercise 67. What counts woolen should be twisted with a 2/60 cotton to make a twist thread equal to 1/20 worsted?

Exercise 68. Required the counts of a cotton thread to be twisted with a No. 80's cotton, to produce a twist or compound thread equal to a 2/60 cotton.

Exercise 69. What will be the count of a single worsted thread to twist with a No. 36's worsted to produce a compound thread equal to a No. 12's worsted?

Exercise 70. Find what counts twisted with No. 24 cotton would produce a compound thread equal to a No. 9 cotton.

Exercise 71. What will be the run of woolen thread, to twist to a 8 run, to produce a double and twist thread equal to a 6 run?

Two known single threads, a third thread is required to produce a known compound thread.

In the cotton trade, worsted and silk threads are twisted to cotton.

In the worsted trade, cotton and silk threads are twisted to worsted.

In the woolen trade, cotton, silk and worsted threads are twisted to woolen.

For the cotton trade, transfer the worsted and silk to cotton counts.

For the worsted trade, transfer the cotton and silk to worsted counts.

For the woolen trade, transfer the cotton, silk and worsted to woolen numbers.

Rule 22. First find the size of twist of the two known threads then proceed as in previous examples.

Find the counts of the third thread to twist with a 1/30's cotton thread, and a 1/60 cotton thread to produce a 3-ply thread equal to a No. 12 cotton.

$$\frac{60 \times 30}{60 + 30} = \frac{1800}{90} = 20\text{'s cotton}$$

$$\frac{20 \times 12}{20 - 12} = \frac{240}{8} = 30\text{'s required.}$$

Proof. 3-ply twist, Nos. 60, 30, 30.

$$\begin{aligned} 60 \div 60 &= 1 \\ 60 \div 30 &= 2 \\ 60 \div 30 &= 2 \\ \hline &\ 5 \end{aligned} \qquad 60 \div 5 = 12\text{'s 3-ply thread.}$$

Find the size of a worsted thread to twist with a 1/30's cotton to produce a 2-ply thread equal to a 2/30 cotton.

$$\tfrac{2}{30} = \tfrac{1}{15}\text{ cotton.}$$

$$\frac{30 \times 15}{30 - 15} = \frac{450}{15} = 30\text{'s cotton.}$$

$$840 \times 30 = \frac{25200}{560} = 45\text{'s required worsted thread.}$$

Exercise 72. Find the size of a single worsted yarn required to produce with an 8-run woolen a compound thread equal to a 6-run woolen.

Exercise 73. Required the count of a spun silk thread to twist with a No. 20 cotton and No. 30 worsted to produce a 3-ply thread equal to a 3½-run woolen.

Exercise 74. A loop yarn has a resultant count of No. 4's cotton. It is composed of 2 threads of 2/28 black cotton and 1 thread grey worsted, there are 2 yards of this last thread used to each yard of cotton. Find the counts of the worsted.

Constants.

In figuring textiles there are many numbers which constantly repeat themselves, thus making it desirable to dispense with some of them by cancelling one into the other, for instance:

$7000 \div 840.\quad 7000 \div 1600.\quad 7000 \div 560$, etc., etc.,

and these numbers used in the reverse order and one multiplied or divided into one or the other is of very frequent occurance. To simplify these calculations the following constants have been worked out.

	LONG METHOD.	FIRST CONSTANT.	SECOND CONSTANT.
Woolen	7000 ÷ 1600 =	4.375 ÷ 36 =	.1215 +
Worsted	7000 ÷ 560 =	12.5 ÷ 36 =	.3472 +
Cotton	7000 ÷ 840 =	8.33 ÷ 36 =	.2314 +
Linen	7000 ÷ 300 =	23.33 ÷ 36 =	.648 +

Woolen	1600 ÷ 7000 = .228 +
Worsted	560 ÷ 7000 = .08
Cotton	840 ÷ 7000 = .12
Linen	300 ÷ 7000 = .043

It is very frequent that the counts of a very small portion of yarn is required, and to obtain the necessary data a pair of fine grain scales is one of the most used and needful apparatus in a manufacturer's and designer's office.

Suppose that in a sample of woolen cloth there are 40 threads per inch and the sample is 2 inches long, then there would be 40 x 2 = 80 inches of yarn and these threads weigh 2.5 grains. What is the run of the yarn?

Rule 23. Multiply the number of inches of yarns by 7000 (the grains in 1 lb.) and divide by the weight (in grains) of the yarn x the standard number x 36. The answer will be the run of the yarn.

$$\frac{80 \times 7000}{2.5 \times 1600 \times 36} = 3.88 \text{ run.}$$

Example. If a sample of cotton cloth has 40 warp threads in one inch and the sample is only 1 inch long and the yarn weighs 2.5 grains. What is the count?

$$\frac{40 \times 7000}{2.5 \times 840 \times 36} = \text{No. } 3.7037$$

Explanation.

As there are 7000 grains in 1 lb. and 840 yds. of No. 1 yarn in 1 lb. 7000 ÷ 840 gives us the number of grains in 1 yd. of No. 1 yarn, or 8 ⅓ grains. The constants, as we have 40 warp threads per inch, 8 ⅓ grains, multiplied by 40 gives us the weight in grains of one running yard of No. 1 warp, 1 inch in width or 333 ⅓ grains.

As 1 in. x 1 in. of warp weighs 2.5 grains, one running yd. 1 in. wide would weigh 2.5 x 36 = 90 grains. Now as 90 grains is the

actual weight of the yarn and 333 ⅓ grains the weight of an equal quantity of No. 1 yarn, the number of our warp yarn would be the number of times the weight of the No. 1 yarn is greater than our yarn, or

$$333.33 \div 90 = 3.7037 \text{ cotton counts.}$$

Example: Supposing 12 threads worsted were obtained each 3 inches long (1 yard) and these weigh 1 grain, what are the counts?

$$\frac{7000}{560} = 12.5 \text{ grains, the weight of 1 yard of No. 1 worsted.}$$

Therefore, if 1 yd. of yarn weighs 12 ½ grains, the counts are 1's or if 2, 3, 4 or 5 yards weigh 12 ½ grains, the counts are 2, 3, 4 or 5's respectively, or the number of yards of yarn which weigh 12 1/2 grains equal the counts in worsted.

Then the counts in the above example would be No. 12 ½, because 12 ½ yards would be required to weigh 12 ½ grains.

The use of the constants.

If 48 inches of woolen yarn weights 2 grains what is the run?

Long Method Woolen.

$$\frac{48 \times 7000}{2 \times 1600 \times 36}$$

```
 1600
    2
 ----
 3200
   36
 ----
19200
 9600
------
115200
```

```
  48
7000
------
336000
```

```
115200)336000.00(2.916 run, say 2.9 run
       230400
       -------
       1056000
       1036800
       -------
         192000
         115200
         ------
          768000
          691200
          ------
           768000
           691200
           ------
            76800
```

FIRST CONSTANT.

$$\frac{48 \times 4.375}{2 \times 36}$$

```
 4.375
    48
 -----
 35000
17500
```

```
36
 2
--
72
```

```
72)210.000(2.916
   144
   ---
   660
   648
   ---
    120
     72
    ---
    480
    432
    ---
     48
```

SECOND CONSTANT.

$$\frac{48 \times 1215}{2}$$

```
   .1215
      48
   -----
    9720
   4860
  ------
2)5.8320
  ------
   2.916
```

CANCELLATION.

$$\frac{\overset{24}{\cancel{48}} \times .1215}{\cancel{2}}$$

```
 .1215
    24
 -----
  4860
 2430
------
2.9160
```

If 75 inches of worsted yarn = 2.5 grains, what is the count?

LONG METHOD.

$$\frac{75 \times 7000}{2.5 \times 36 \times 560} = 10.416$$

FIRST CONSTANT.

$$\frac{75 \times 12.5}{2.5 \times 36} = 10.416$$

SECOND CONSTANT.

$$\frac{75 \times .3472}{2.5} = 10.416$$

CANCELLATION.

$$\frac{\overset{30}{\cancel{75}} \times .3472}{\cancel{2.5}} = 30 \times .3472 = 10.416$$

If 96 inches of cotton yarn = 2 grains, what is the count?

LONG METHOD.

$$\frac{96 \times 7000}{2 \times 840 \times 36} = 11.10$$

FIRST CONSTANT.

$$\frac{96 \times 8.33}{2 \times 36} = 11.10$$

SECOND CONSTANT.

$$\frac{96 \times .2314}{2} = 11.10$$

CANCELLATION.

$$\frac{\overset{48}{\cancel{96}} \times .2314}{\cancel{2}} = 48 \times .2314 = 11.10$$

Work out each exercise by all the four methods.

Exercise 75. If the warp yarn in 1 inch x 1 inch of woolen cloth weighs 2 grains, and there are 60 threads per inch, what is the run of the yarn?

Exercise 76. If 44 inches of cotton yarn = 1 ½ grains, what is the counts of the yarn?

Exercise 77. If 60 inches of worsted yarn = 1.2 grains, what is the counts of the yarn?

Exercise 78. If 1 sq. inch = 1.9 grains 38 threads per inch in the warp worsted = 1 grain, 30 picks per inch = .9 grains, 15 inches cotton = .3 grains, 15 inches worsted = .6 grains, what are the counts of each yarn?

Exercise 79. Fifty inch print cotton warp=.8 grs. 80 inch blue cotton warp = 1.4 grs. 100 inch purple cotton filling = 1.2 grs. 140 inch yellow spun silk = .5 grs. 90 inch brown worsted filling = 1.7 grs. What are the counts of each yarn?

SPECIFICATIONS FOR WORSTED AND WOOLEN FABRICS.

(*a*) Method of figuring texture and weight of finished cloth.

The texture of a finished cloth is governed by the diameter of the finished yarn and the weave used to give the desired effect to the fabric. When the counts of the finished yarn are unknown, the counts of the yarn in the loom, are multiplied by the total warp or filling shrinkage percentage. This will give the required counts of the finished yarn. If the counts of the finished yarn are known, the process of finding the texture of the finished cloth is as follows:

Example 1. A fabric is required 2/36 worsted finished warp and filling counts, weave cassimere twill. Warp dressed black 6, red 2, black 12, white 2, black 6 = 28 threads in pattern. Filling solid black. Find the texture of the finished cloth, weight of finished warp and filling in one yard of finished cloth.

First find the texture of the finished cloth. Multiply the finished counts by the standard number of the given yarn, and extract the square root of the result. This will give the number

of smooth, solid cylinders of the same diameter as the yarn in one inch. The fibres of the several varieties of yarn extend more or less from the yarn, the amount varying according to the quality of the yarn or turns per inch. For this reason a certain percentage must be allowed for the decrease in the number of threads that will lay side by side in one inch. Upon examination of a wool, worsted, cotton or silk thread, it may be seen that the wool yarn is the roughest, worsted a trifle smoother than wool, cotton smoother than worsted and the silk thread comparatively smooth and resembling the solid cylinder used as the basis of calculation. The approximate percentages allowed are wool 16, worsted 10, cotton 7 and silk 4.

The number of threads of 2/36 worsted that will lay side by side in one inch is found by the following formulæ:

$\frac{2}{36}$ = single 18. 18 x 560 = 10080. $\sqrt{10080}$ = 100.39
100.39 cylinders side by side in one inch.
100.39 — 10% = 90.36 threads of $\frac{2}{36}$ side by side in one inch

Dividing this result by 2 gives the number of threads per inch of 2/36 worsted in plain weave.

90.36 ÷ 2 = 45.18 threads plain weave, finished cloth

This result multiplied by the number of units of plain weave and the product divided by the number of units in an equal number of threads of the required weave will give the number of threads per inch of the required weave in finished cloth.

Units in 4 threads of plain weave, 8
Units in 4 threads of cassimere twill, 6
45.18 x 8 ÷ 6 = 60.24 threads per inch cassimere twill.

The general rule is to use the nearest whole number for the threads per inch. In this case the threads per inch for a finished fabric 2/36 worsted finished counts, cassimere twill is 60. The number of picks per inch is approximately the same.

The weight of finished warp and filling in one yard of cloth is found by the regular analysis method. Multiply the counts by the standard number to find the number of yards in one pound.

Dividing the number of yards of each color of warp or filling in one yard of finished cloth by this length gives the weight of each color in pounds. To find the weight in ounces multiply the result or weight in pounds by 16 the number of ounces in one pound. The fabric is 56 inches wide finished, inside selvedges, 60 threads and 60 picks per inch finished. To find the

number of yards of warp or filling in one yard of the finished fabric multiply the width by the number of threads or picks per inch.

60 x 56 = 3360 yards of finished warp.
60 x 56 = 3360 yards of finished filling.

To find the yards of each color divide the number of threads in warp or picks in filling by the threads or picks in a pattern. This will give the number of patterns. The number of patterns multiplied by the threads or picks of each color in a pattern will give the number of yards of each color in one yard of cloth.

3360 ÷ 28 = 120 patterns in warp.
Filling solid black.

WARP.	Black	24	24 x 120 x 16 ÷ 18 x 560 =	4.571 oz.
	Red	2	2 x 120 x 16 ÷ 18 x 560 =	.381 oz.
	White	2	2 x 120 x 16 ÷ 18 x 560 =	.381 oz.
				5.333 oz.
FILLING.	Black solid.		3360 x 16 ÷ 18 x 560 =	5.333 oz.
	Weight of one yard finished cloth			10.666 oz.

Shrinkages.

Woolen and worsted fabrics are figured by shrinkage percentages. Before commencing the subject of figuring weights or counts of yarn, the principles of shrinkage and their effect upon the fabric during the various processes of manufacture must be understood.

When a warp is put in the loom, or is on the warp beam, it is at its longest length, and under a certain amount of tension. The warp counts are the finest at this stage, and the weight per yard the lightest. The warp is interwoven by the filling, the fabric wound on the cloth roll and taking from the loom. During this process the tension of the loom has been released and the warp wrapping more or less around the filling shortens the warp. The weight per yard and the diameter of the warp yarn have increased in proportion to the weaving percentage. These differences are caused by what is commonly termed the weaving percentage. The fabric is then subjected to the various finishing processes which shrink the cloth in length, increase the diameter of the warp yarn and increase the number of picks per inch. The filling percentage influences the width of the cloth, making the finished width narrower, and the diameter of the filling greater in the finished cloth.

Total warp percentage: Diameter of finished warp yarn increased from the yarn on warp beam, and length of finished cloth decreased from the dressed length.

Weaving percentage: Diameter of warp yarn in woven cloth increased from yarn on warp beam, weight of woven cloth per yard increased, length of woven cloth decreased.

Finishing percentage: Weight per yard of finished cloth and diameter of finished warp yarn increased from woven. Picks per inch in finished cloth increased from woven.

Filling percentage: Diameter of filling yarn and threads per inch in the finished cloth increased. Width of finished cloth decreased from woven.

The above are given from loom to finished cloth. For finished to loom the reverse is true.

Example 2. 378 yards of woven cloth have lost 5½% in weaving, and finished to 321.3 yards in length. Find the length on warp beam, finishing and total percentages.

378 yards of woven cloth represent a loss of 5½% of the original length, 100 — 5½% = 94 ½%.

378 yards represent 94½% of the length on the warp beam.

378 ÷ .945 = 400 yards length on the warp beam.

Length of woven cloth 378 yards, finished cloth 321.3 yards.
Loss in length 378 — 321.3 = 56.7 yards.
Loss in percentage 56.7 ÷ 378 = .15 or 15% finishing.

Length of warp on warp beam 400 yards, finished 321.3 yards.
Loss in length 400 — 321.3 = 78.7 yards.
Loss in percentage 78.7 ÷ 400 = .1967 or 19.67% total.

To prove the above percentages subtract both weaving and finishing percentages from 100 and multiply the results.

100 — 5½ = 94½
100 — 15 = 85
.945 x .85 = .80325 or 80.325

Subtracting this result from 100 should prove the total percentage.

100 — 80.325 = 19.675% total warp.

The greatest length or width is considered 100% in shrinkage and all calculations for shrinkage percentage are figured on that principle.

The finishing percentage applies to the woven length, not to the length on warp beam and accounts for the fact that the weaving and finishing percentages added do not equal the total percentage.

Example 3. A warp 64 inches wide in the loom is 55 inches wide finished. Find the percentages of take up and shrinkage.

Finished width is always inside selvedges, and loom width including selvedges, unless stated otherwise. For that reason

one inch for selvedges must be added to the finished width to place both widths on the same basis. 55 + 1 = 56 inches finished width.

64 — 56 = 8 inches loss, caused by the filling, therefore filling percentage loss.

Dividing this loss by the loom width will give the shrinkage percentage, or dividing by the finished width will give the take-up percentage. In shrinkage loom length, width or counts equal 100%. In take up finished length, width or counts equal 100%. The loss in width divided by the loom width gives the shrinkage percentage, or the loss divided by the finished width gives the take up percentage.

8 ÷ 64 = 12½% shrinkage. 8 ÷ 56 = 14 2/7% take up

The method of figuring for a finished cloth, from certain sizes of yarn on hand is as follows:

Example 4. A fabric is woven from 4.5 run warp 5 run filling, 56 threads and 64 picks per inch finished. Finished width inside selvedges, 56 inches. Add 1 inch for selvedges. Percentages warp: total 17¾, weaving 6, finishing 12½. Filling 10%. Reed, 2 in a dent. Weave, cassimere twill, selvedges plain. Warp 250 yds. long on warp beam. All calculations to be figured including selvedges.

The requirements for the specifications are as follows:

(a) Run of yarn in finished cloth.
(b) Threads and picks per inch in loom.
(c) Length of woven and finished cloth.
(d) Weight of 1 yard of finished cloth.
(e) Weight of warp yarn in 1 yard on warp beam.
(f) Weight of warp yarn in 1 yard on cloth roll.
(g) Width in loom and reed.
(h) Weight of filling yarn in 1 yard on cloth roll.
(i) Weight of required length of warp on warp beam.
(j) Weight of required length on cloth roll.
(k) Weight of required length of finished cloth.
(l) Number of heddles on each harness.

(*a*) Run of yarn in the finished cloth.

The given run of warp is at the warp beam, and for the filling in the shuttle. To find the finished warp counts multiply the given run by the total warp percentage, for both weaving and finishing influence the size of the original warp making the diameter of the finished yarn larger, and the number representing the size less. To find the size of the finished filling yarn

multiply by the filling percentage, this percentage influencing the size of the yarn and acting in a similar manner as the total warp on the warp yarn.

4.5 x .8225 = 3.701 finished warp.
5 x .90 = 4.5 finished filling.

(*b*) Threads and picks per inch in loom.

The number of threads per inch is influenced by the filling percentage, the filling controlling the width of the cloth. The number of threads in the loom will be less than in the finished cloth, therefore, multiply the finished threads per inch by the filling percentage.

56 x .90 = 50.4 threads per inch in loom.

The finishing process controls the number of picks per inch. As the number of picks per inch in loom will be less than in the finished cloth, multiply the pick per inch in finished cloth by the finishing percentage.

64 x .875 = 56 picks per inch in loom.

(*c*) Length of woven and finished cloth.

The length of woven cloth is decreased by the weaving percentage. From the woven to the finished cloth the length is decreased by the finishing percentage. To find the length of the woven cloth multiply the length on warp beam by the weaving percentage.

250 x .94 = 235 yards length of woven cloth.

The length of finished cloth is found by multiplying the length of woven cloth by the finishing percentage.

235 x .875 = 205.625 yards length of finished cloth.

(*d*) Weight of 1 yard of finished cloth (including selvedges).
Width including selvedges 57 inches.
Finished warp run, 3.701, finished filling run 4.5, 56 threads and 64 picks per inch finished cloth.

WARP.	57 x 56 x 16 ÷ 3.701 x 1600 =	8.624 ounces.
FILLING.	57 x 64 x 16 ÷ 4.5 x 1600 =	8.106 ounces.
	Weight of 1 yard finished	16.730 ounces.

(*e*) Weight of warp yarn in 1 yard on warp beam.
Width including selvedges, 57 inches.
Loom run of warp 4.5

FORMULA. 57 x 56 x 16 ÷ 4.5 x 1600 = 7.093 ounces.

(*f*) Weight of warp yarn in 1 yard on cloth roll.

The weight of warp in 1 yard on cloth roll has increased from warp in 1 yard on warp beam according to the weaving percentage. Divide the weight on warp beam by the weaving percentage.

$$7.093 \div .94 = 7.545 \text{ ounces.}$$

This result may be proved by using the formula at (*e*) substituting the woven counts for the loom counts.

$$4.5 \times .94 = 4.23$$
$$57 \times 56 \times 16 \div 4.23 \times 1600 = 7.546 \text{ ounces.}$$

(*g*) Width in loom, and reed.

The width in loom is influenced by the filling percentage, and is wider than in the finished cloth. Divide the finished width including selvedges by the filling percentage.

$$57 \div .90 = 63.333 \text{ inches.}$$

The total number of threads in warp divided by this result will give the number of threads per inch in loom.

$$57 \times 56 = 3192 \div 63.333 = 50.4 \text{ threads per inch.}$$

This is the same result as found at (*b*) by multiplying the number of threads per inch finished by the filling percentage. Dividing the threads per inch in loom by the threads in a dent gives the number of dents per inch or the reed.

$$50.4 \div 2 = 25.2 \text{ reed.}$$

(*h*) Weight of filling yarn in 1 yard on cloth roll.

The width at the reed is 63 ⅓ inches. The number of picks per inch in loom 56. To find the number of yards of filling in 1 yard on the cloth roll multiply the picks per inch in loom by the loom width. The weight of filling yarn in 1 yard of cloth on the cloth roll is found by the same principle as the filling in finished cloth substituting loom counts for finished counts and using the number of yards of filling found above.

$$56 \times 63\tfrac{1}{3} \times 16 \div 5 \times 1600 = 7.093 \text{ ounces.}$$

Adding the weight of warp and filling yarn in 1 yard of cloth on cloth roll gives the weight of 1 yard.

$$7.546 \text{ plus } 7.093 = 14.639 \text{ ounces.}$$

Dividing this weight by the finishing percentage (12½) will give the weight after finishing the cloth.

$$14.639 \div .875 = 16.730 \text{ ounces,}$$

which proves with the weight of 1 yard of finished cloth found in question (*d*).

(*i*) Weight of required length of warp on warp beam.

The weight of warp yarn in 1 yard on the warp beam is 7.093 ozs. Length of warp on warp beam 250 yards. The weight required is therefore

250 x 7.093 or 1773.25 oz., or 110 lbs., 13.25 oz.

(*j*) Weight of required length on cloth roll.

The weight required on the cloth roll is of the woven cloth, therefore the weight of both warp and filling must be considered. Length of cloth on cloth roll 235 yards. Weight of warp 7.546 ozs. Filling 7.093 ozs.

WARP.	235 x 7.546 = 1773.31 oz., or	110 lbs..	13.31 oz.
FILLING.	235 x 7.093 = 1666.85 oz., or	104 lbs.,	2.85 oz.
Total.	235 x 14.639 = 3440.16 oz., or	215 lbs.,	.16 oz.

(*k*) Weight of required length of finished cloth.

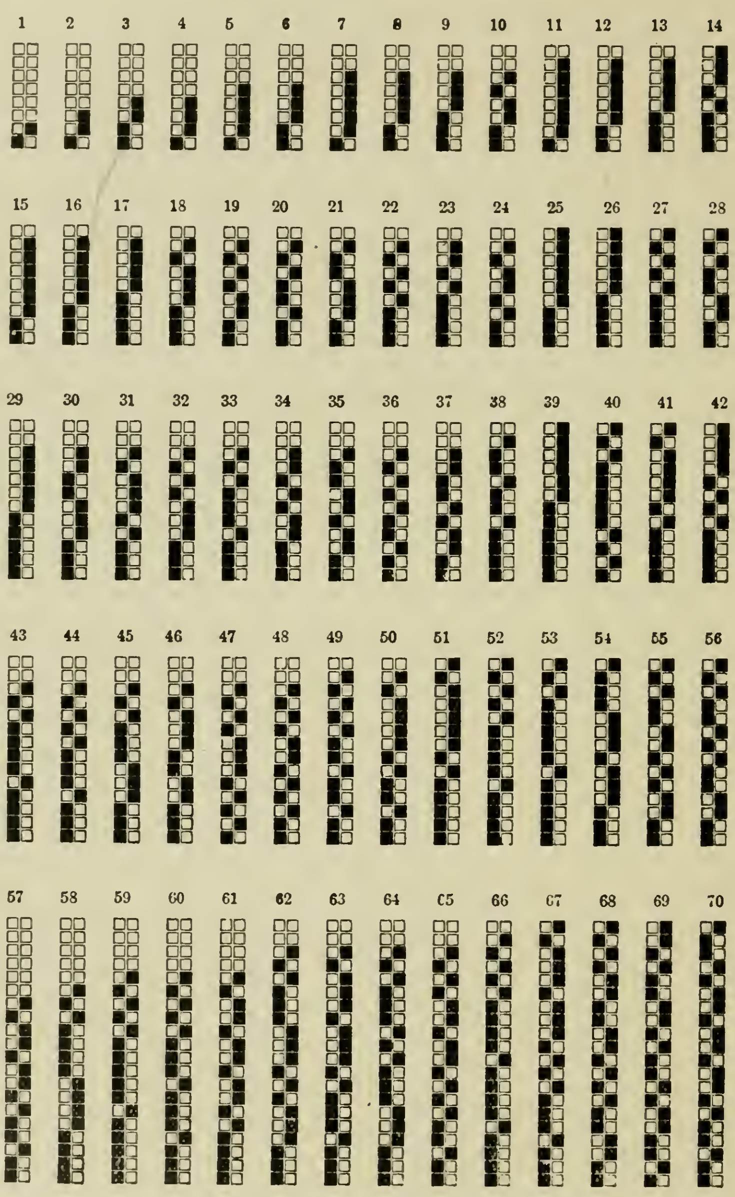
Proceed as in (*j*) using finished length and weights. Length of finished cloth 205.625 yards. Weight of finished warp 8.624 oz., filling 8.106 oz.

WARP.	205.625 x 8.624 = 1773.31 oz., or	110 lbs.,	13.31 oz.
FILLING.	205.625 x 8.106 = 1666.80 oz., or	104 lbs.,	2.80 oz.
Total.	205.625 x 16.73 = 3440.11 oz., or	225 lbs.,	.11

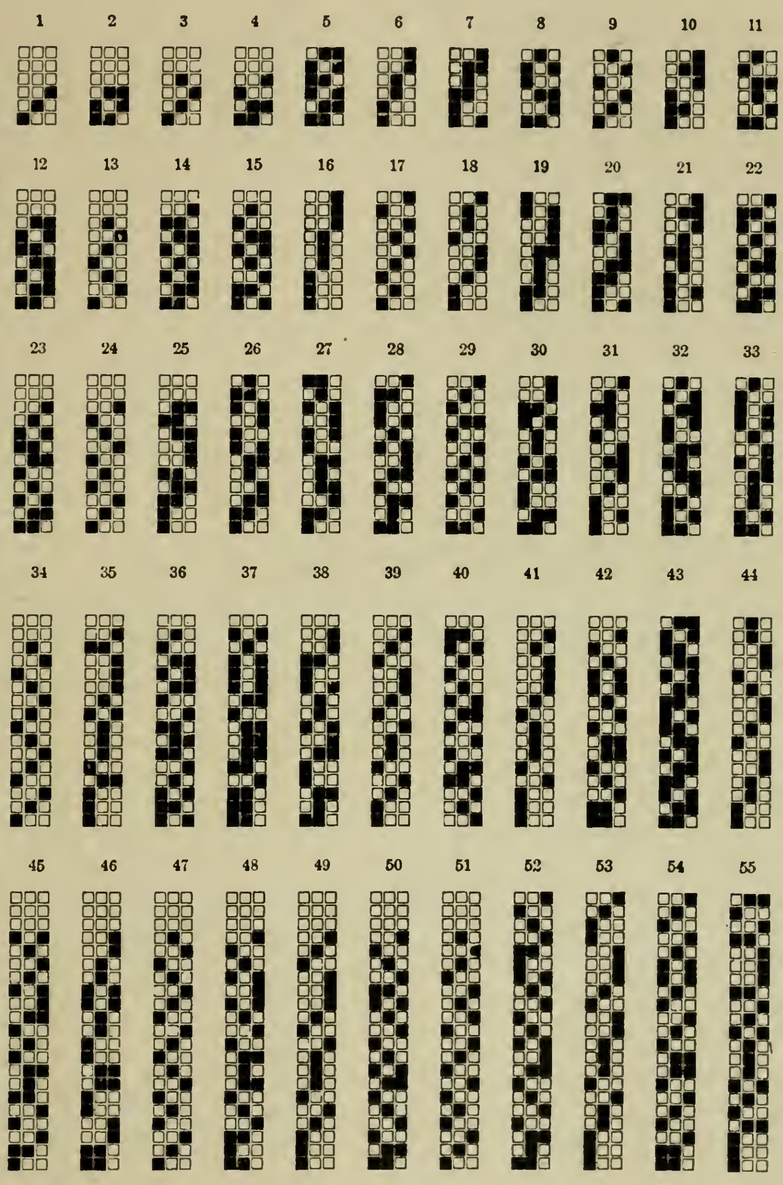
(*l*) Number of heddles on each harness.

Selvedges are generally drawn in on the front harnesses. As the selvedges on this cloth are plain two harnesses are required, 56 threads of selvedge. $56 \div 2 = 28$ heddles on harnesses 1 and 2. Body of warp 56 inches wide, 56 threads per inch, weave cassimere or four harness. $56 \times 56 \div 4 = 784$ heddles on harnesses 3, 4, 5 and 6.

A 2 HARNESS. 2 to 20 PICKS.



B 3 HARNESS. 3 to 21 PICKS.



C

4 HARNESS. 4 PICKS.

1 2 3 4 5 6 7 8 9

10 11 12 13 14 15 16 17 18

19 20 21 22 23 24 25 26 27

28 29 30 31 32 33 34 35 36

4 HARNESS. 6 PICKS.

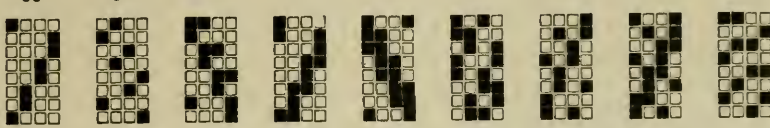
37 38 39 40 41 42 43 44 45

46 47 48 49 50 51 52 53 54

C

4 HARNESS. 8 PICKS.

55 56 57 58 59 60 61 62 63



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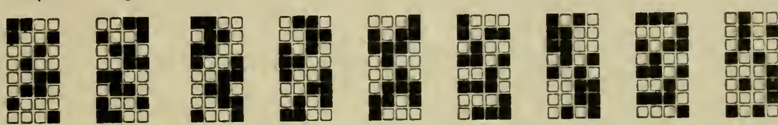

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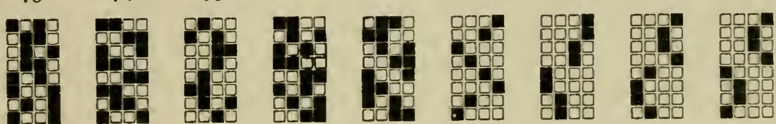

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4 HARNESS. 12 PICKS.

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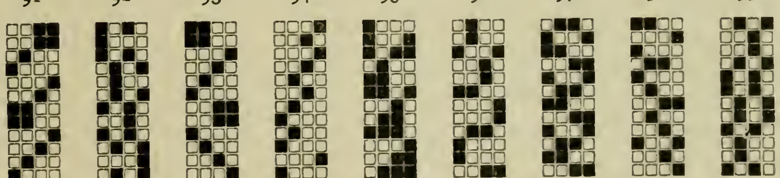

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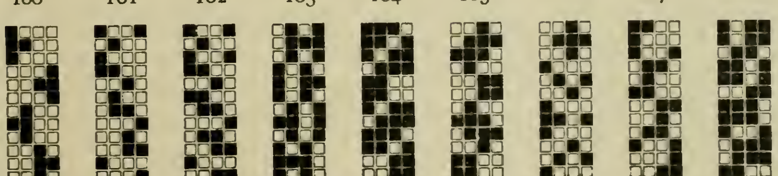

C

4 HARNESS. 16 PICKS.

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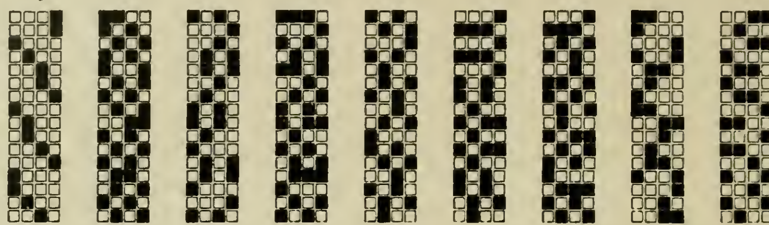

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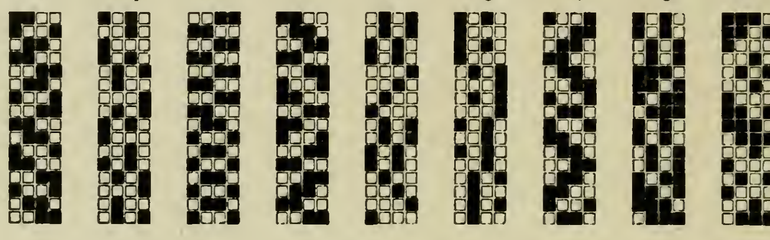

4 HARNESS. 20 PICKS.

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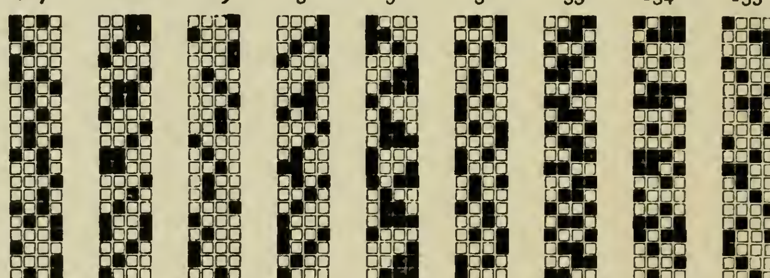

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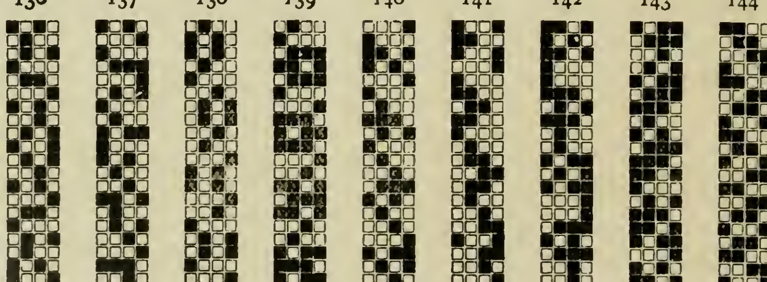

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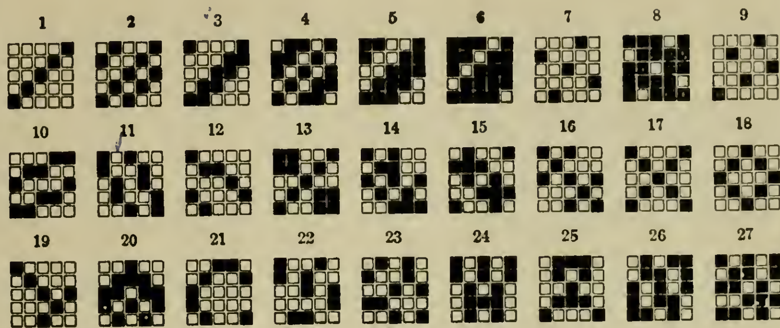
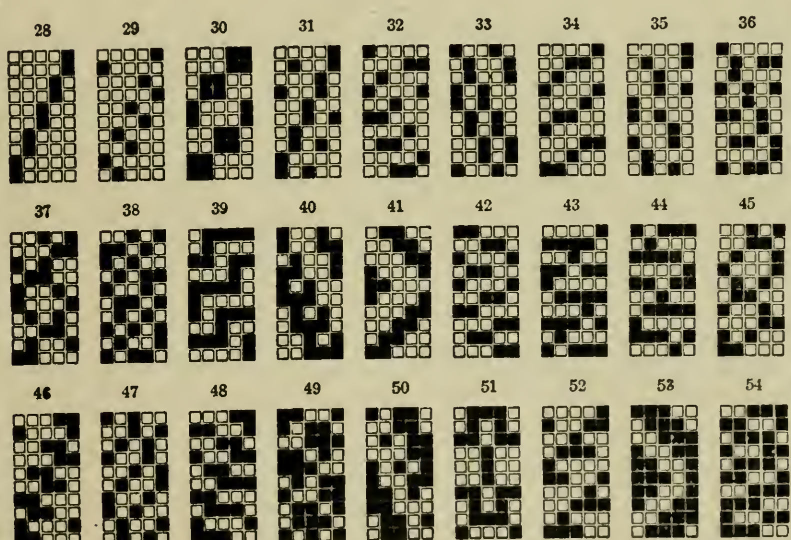
5 HARNESS. 5 PICKS.



5 HARNESS. 10 PICKS.



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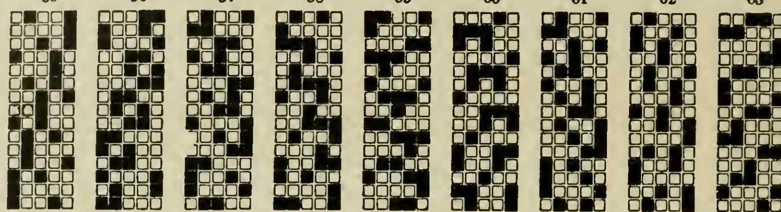

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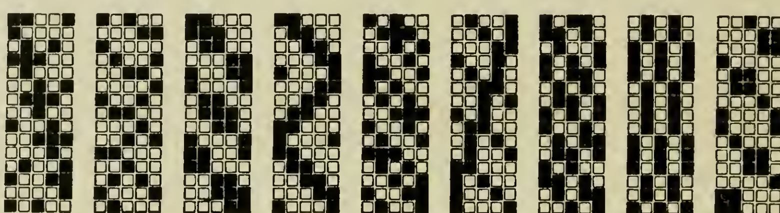

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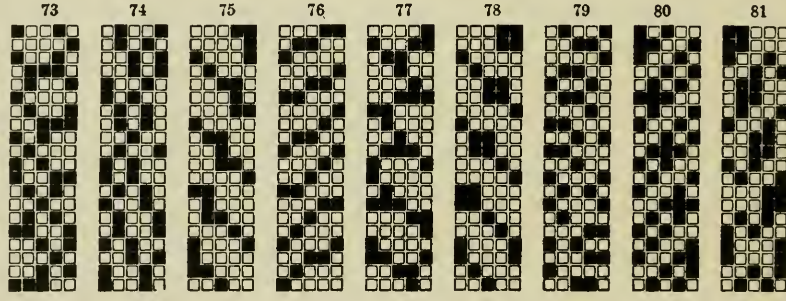

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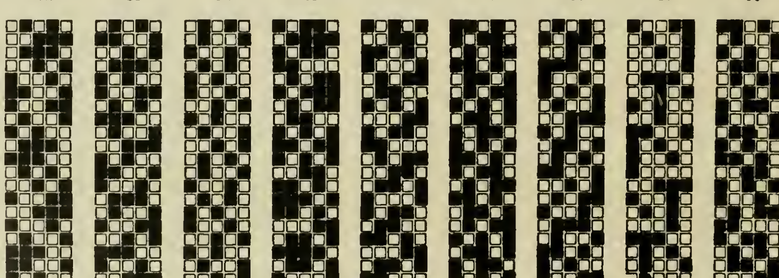

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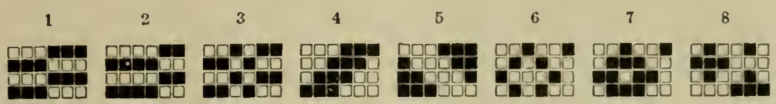

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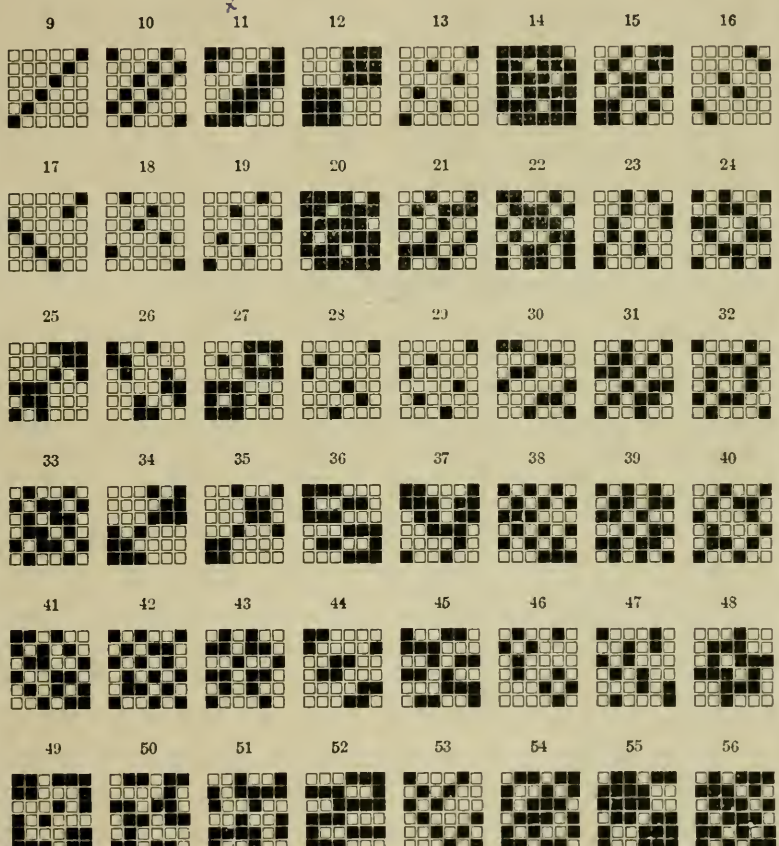

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6 HARNESS. 8 PICKS.

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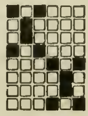
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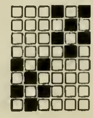
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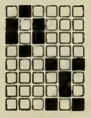
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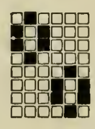
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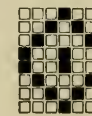
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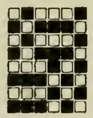
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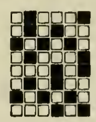
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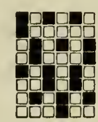
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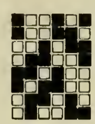
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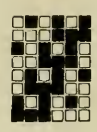
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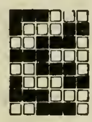
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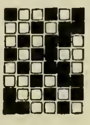
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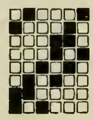
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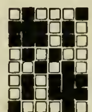

6 HARNESS 10 PICKS.

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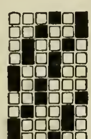
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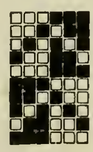
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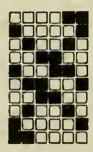
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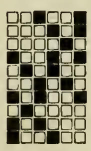
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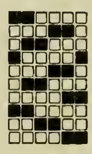
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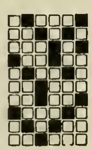
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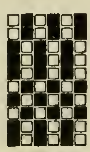
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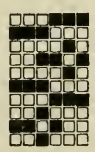
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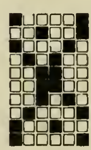
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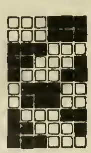
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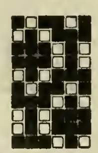
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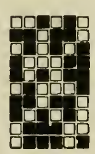
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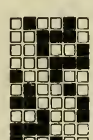

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6 HARNESS. 12 PICKS.

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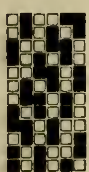

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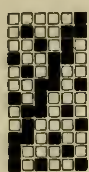

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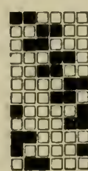

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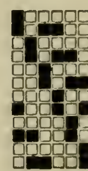

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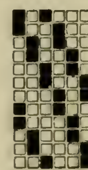

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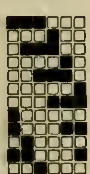

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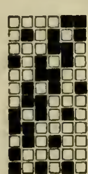

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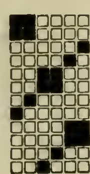

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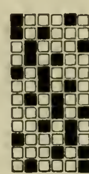

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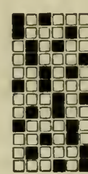

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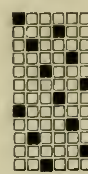

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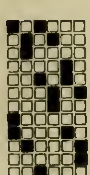

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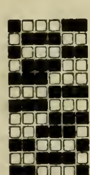

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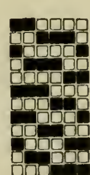

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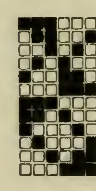

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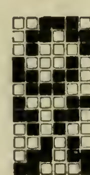

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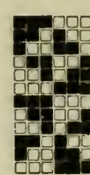

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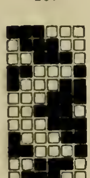

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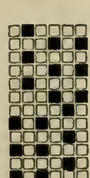

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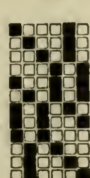

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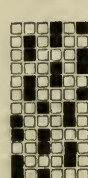

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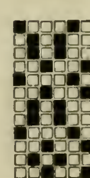

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6 HARNESS. 18 PICKS.

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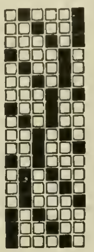
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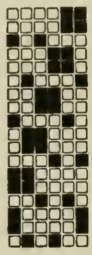
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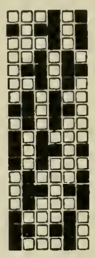
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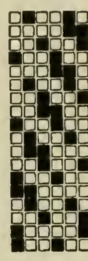
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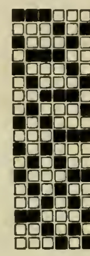
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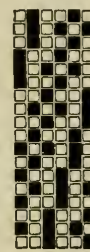

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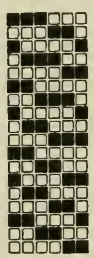
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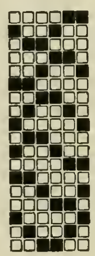
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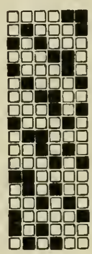
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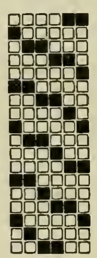
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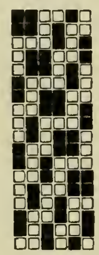
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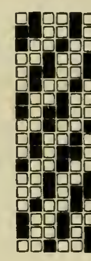

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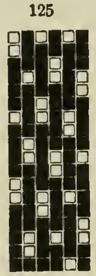
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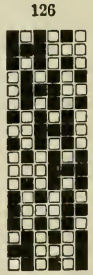
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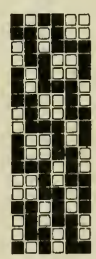
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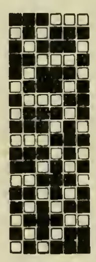
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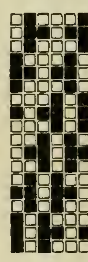
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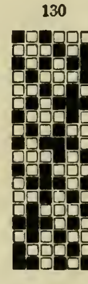

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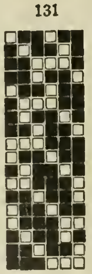
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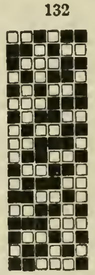
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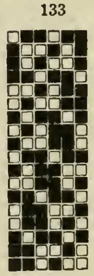
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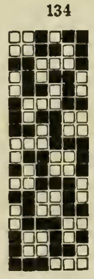
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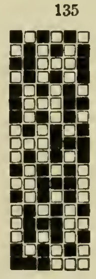
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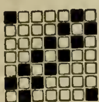
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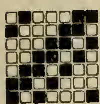
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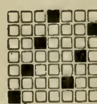
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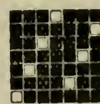
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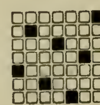
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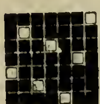
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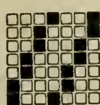
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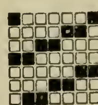
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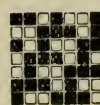
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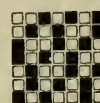
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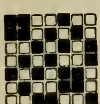
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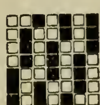
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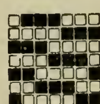
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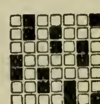
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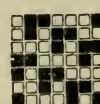
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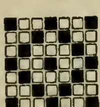
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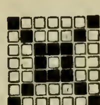
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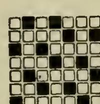
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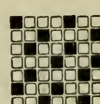
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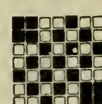
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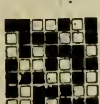
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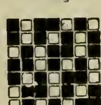
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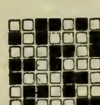
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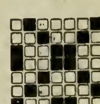

7 HARNESS. 14 PICKS.

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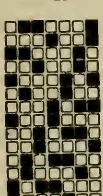
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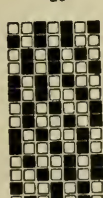
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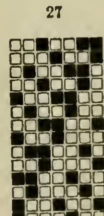
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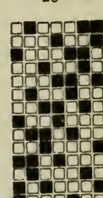
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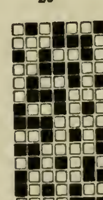

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7 HARNESS. 14 PICKS.

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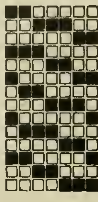

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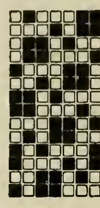

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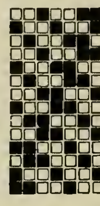

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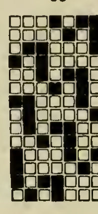

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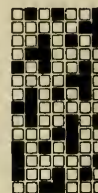

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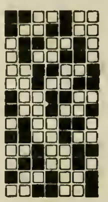

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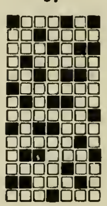

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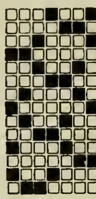

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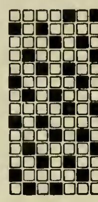

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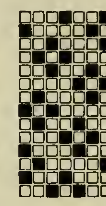

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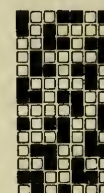

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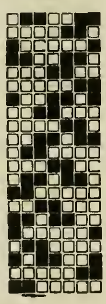

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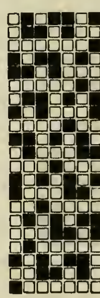

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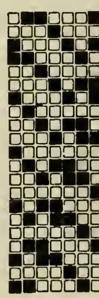

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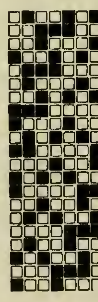

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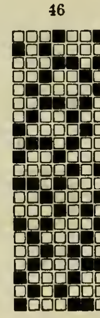

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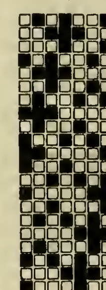

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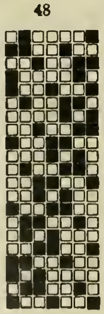

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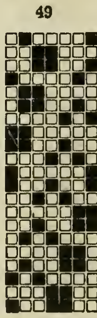

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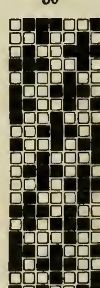

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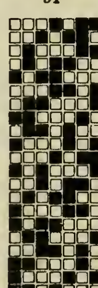

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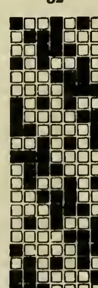

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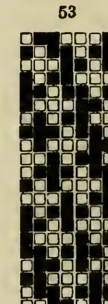

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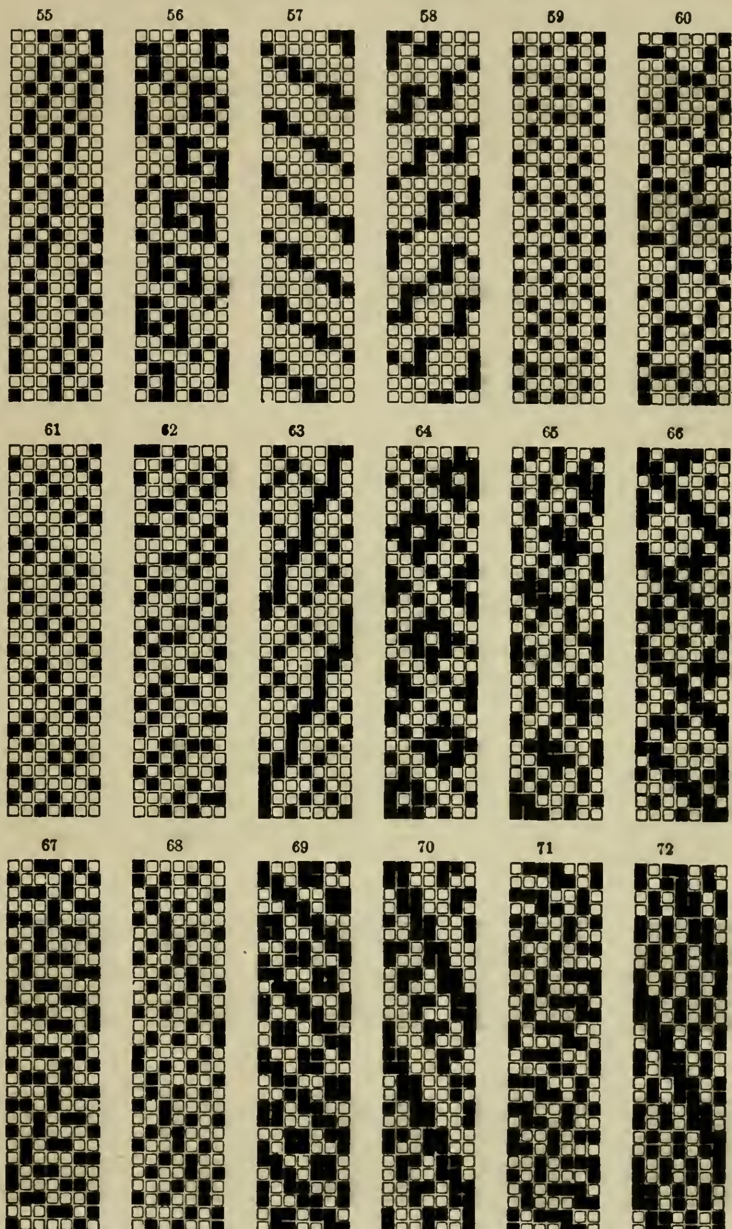

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8 HARNESS. 4 PICKS.

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8 HARNESS. 5 PICKS.

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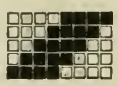

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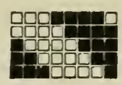

8 HARNESS. 8 PICKS.

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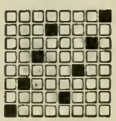

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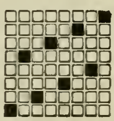

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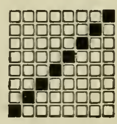

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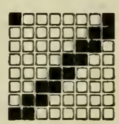

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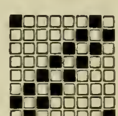

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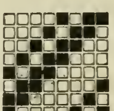

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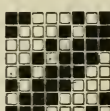

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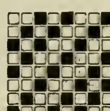

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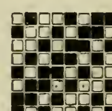

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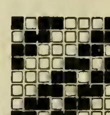

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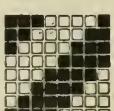

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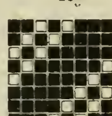

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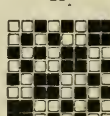

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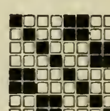

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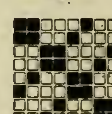

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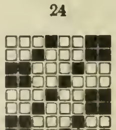

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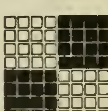

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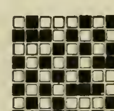

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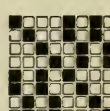

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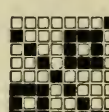

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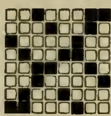
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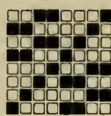
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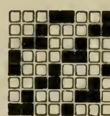
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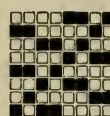
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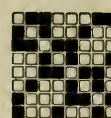
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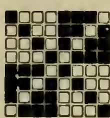
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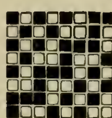
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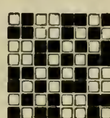
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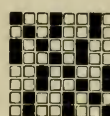
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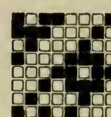
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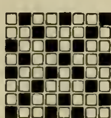
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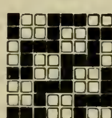
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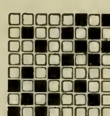
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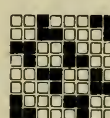
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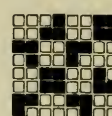
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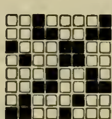
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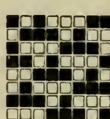
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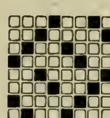
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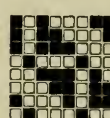
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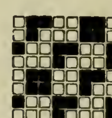
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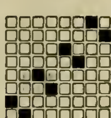
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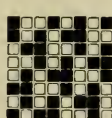
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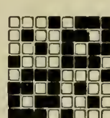
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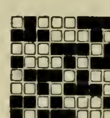
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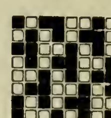
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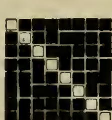
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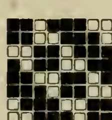
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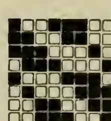
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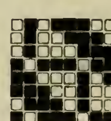
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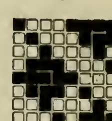
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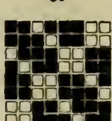
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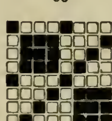
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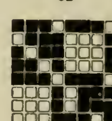
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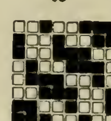

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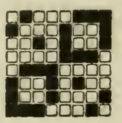
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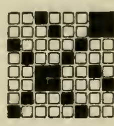
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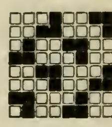
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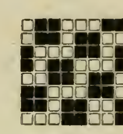
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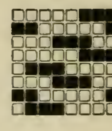
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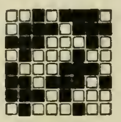
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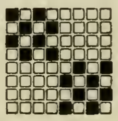
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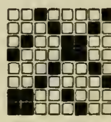
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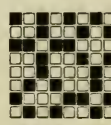
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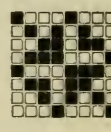
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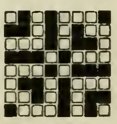
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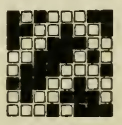
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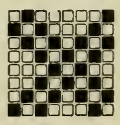
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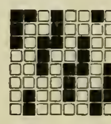
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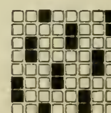
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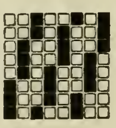
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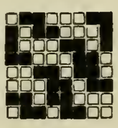
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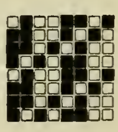
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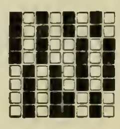
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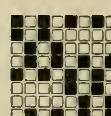
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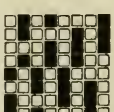
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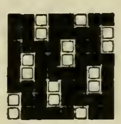
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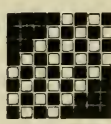
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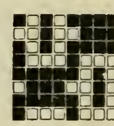
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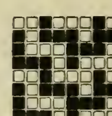
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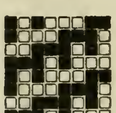
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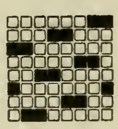
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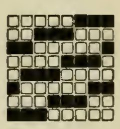
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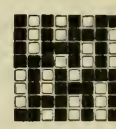
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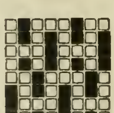
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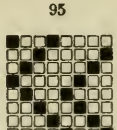
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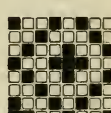
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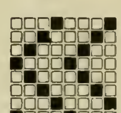
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8 HARNESS. 8 PICKS.

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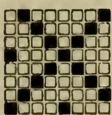
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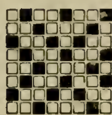
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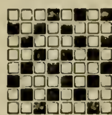
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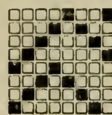
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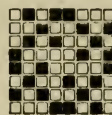
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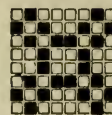

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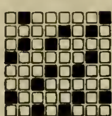
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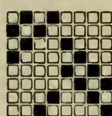
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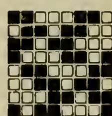
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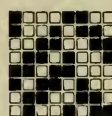
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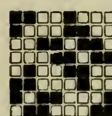
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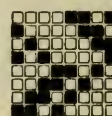

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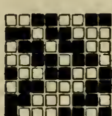
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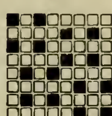
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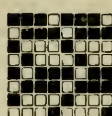
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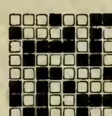
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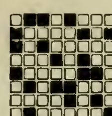
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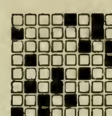

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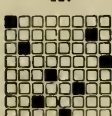
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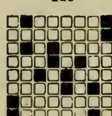
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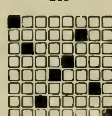
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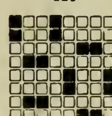
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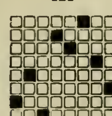
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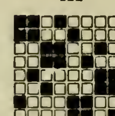

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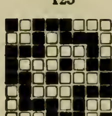
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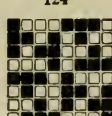
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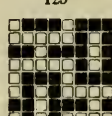
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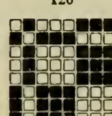
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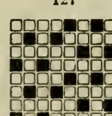
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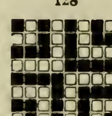

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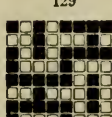
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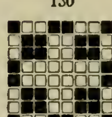
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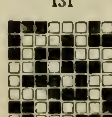
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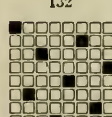
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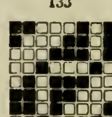
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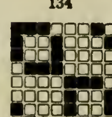

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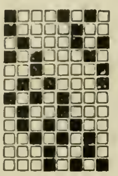
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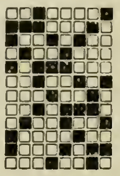
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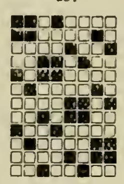
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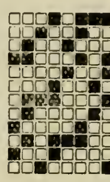
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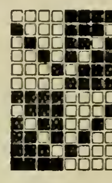
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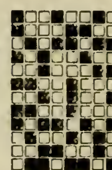
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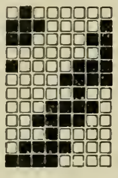
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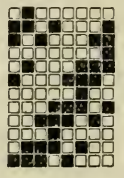
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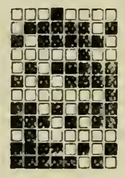
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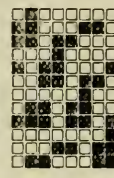
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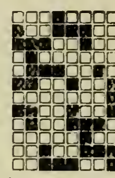
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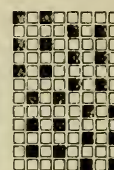
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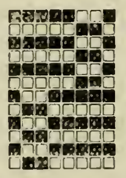
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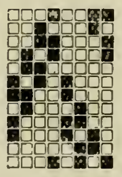
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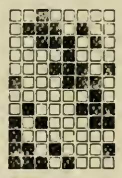
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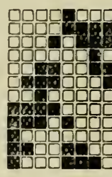
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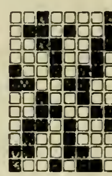
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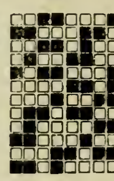

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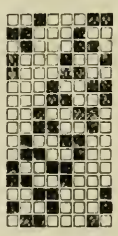
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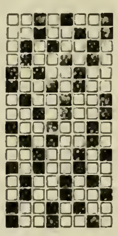
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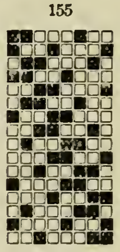
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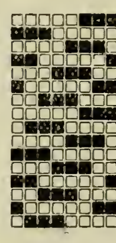
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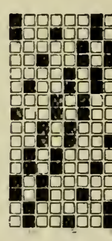
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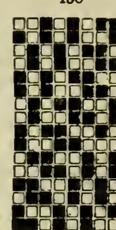
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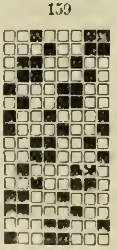
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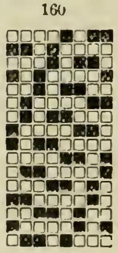
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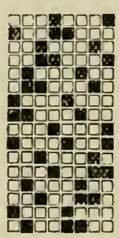
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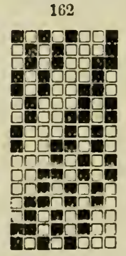
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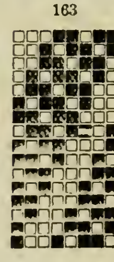
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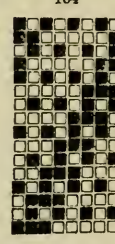

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8 HARNESS. 16 PICKS.

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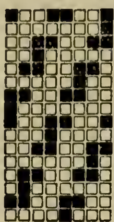
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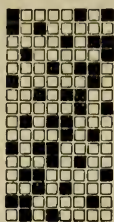
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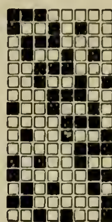
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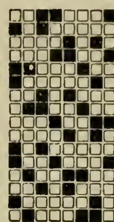
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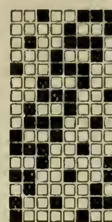
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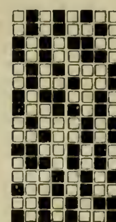
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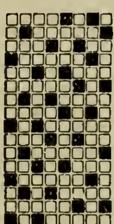
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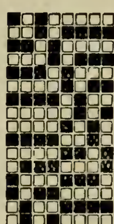
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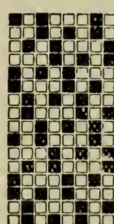
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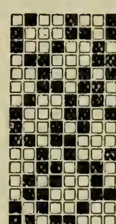
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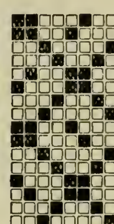
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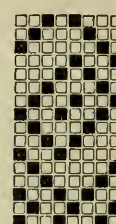
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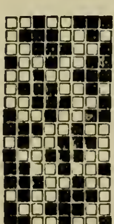
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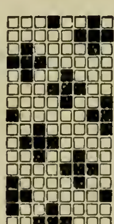
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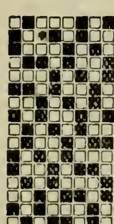
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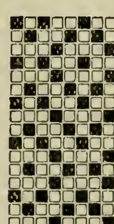
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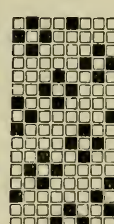
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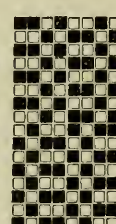
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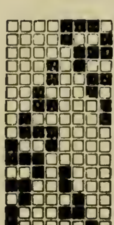
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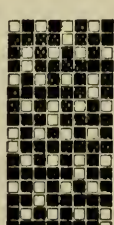
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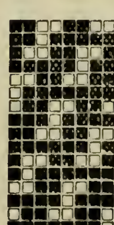
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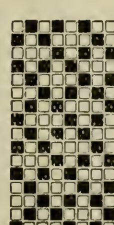
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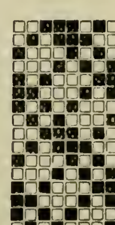
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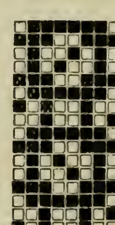

G 8 HARNESS. 24 PICKS.

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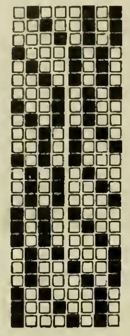

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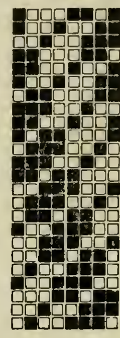

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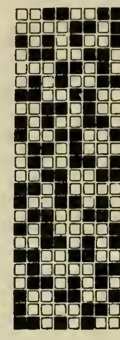

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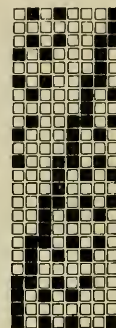

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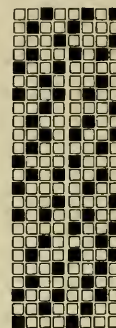

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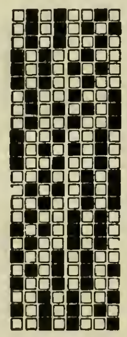

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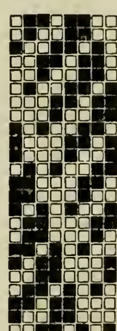

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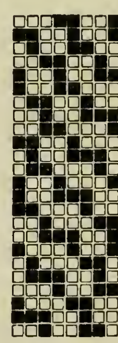

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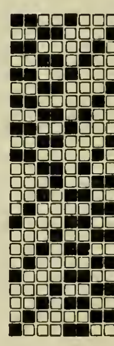

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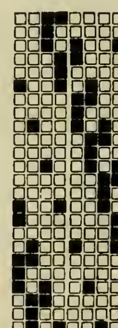

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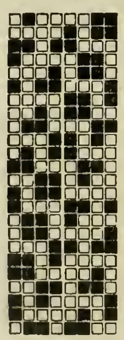

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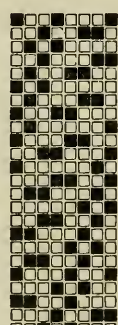

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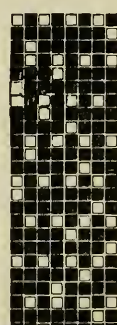

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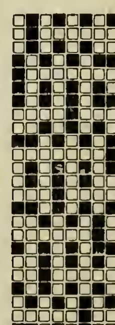

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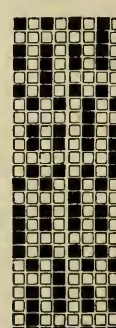

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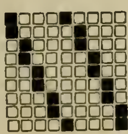

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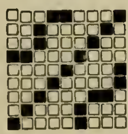

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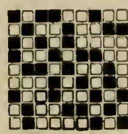

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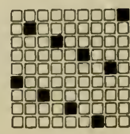

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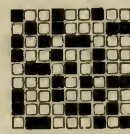

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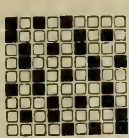

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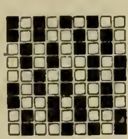

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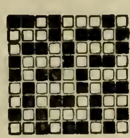

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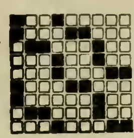

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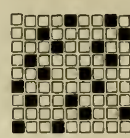

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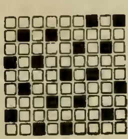

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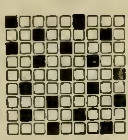

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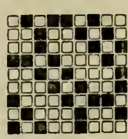

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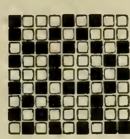

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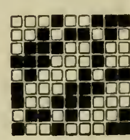

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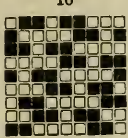

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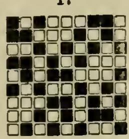

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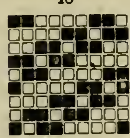

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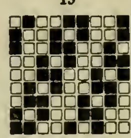

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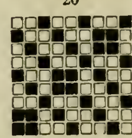

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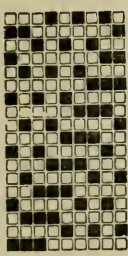

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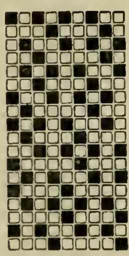

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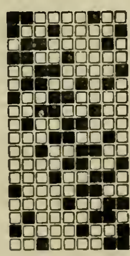

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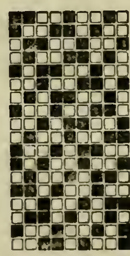

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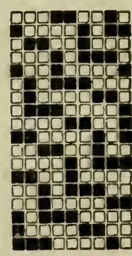

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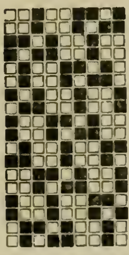

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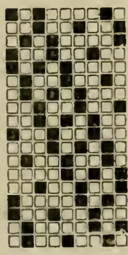

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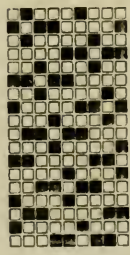

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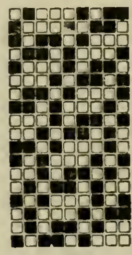

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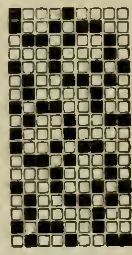

9 HARNESS. 18 PICKS.

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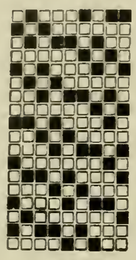

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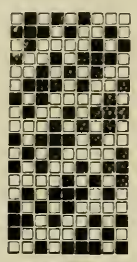

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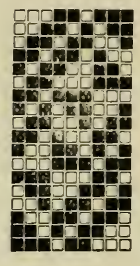

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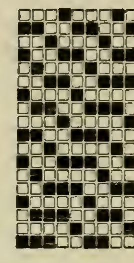

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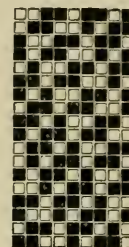

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9 HARNESS. 27 PICKS.

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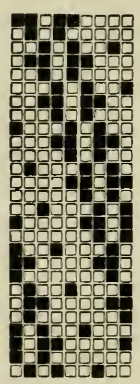

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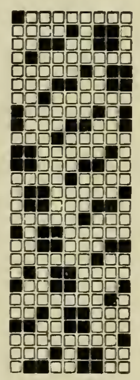

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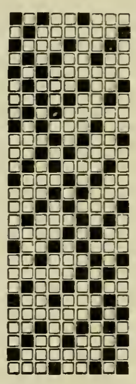

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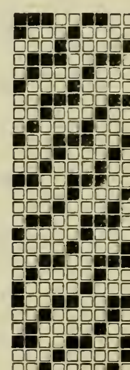

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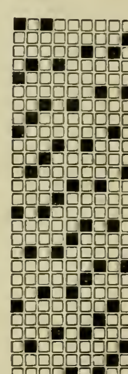

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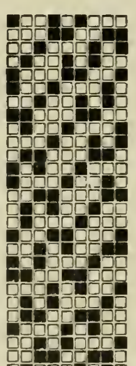

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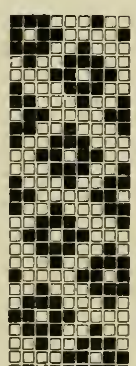

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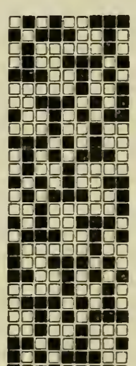

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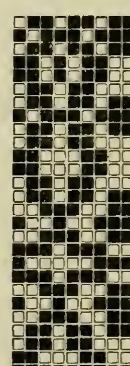

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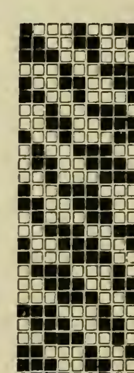

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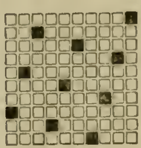

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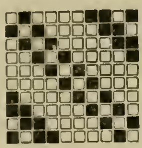

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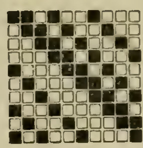

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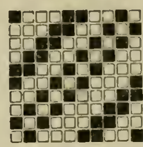

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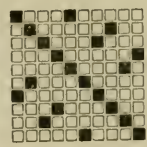

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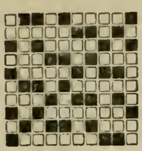

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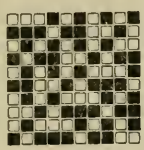

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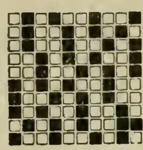

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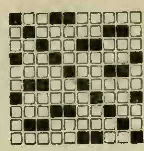

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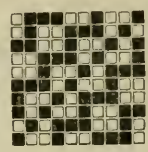

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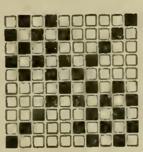

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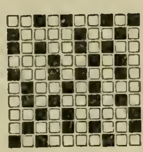

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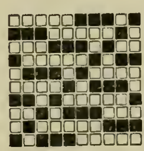

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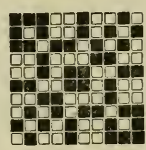

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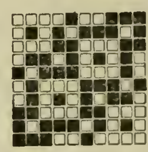

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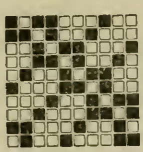

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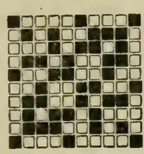

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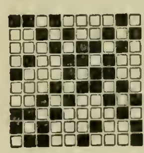

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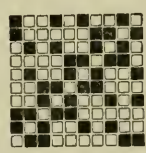

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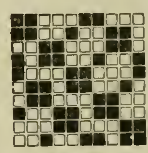

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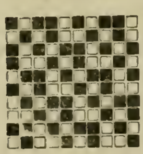

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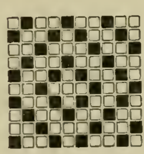

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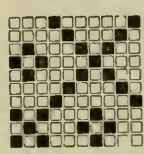

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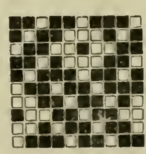

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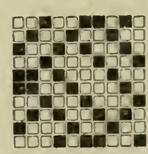

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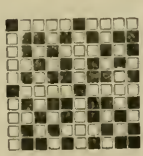

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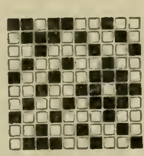

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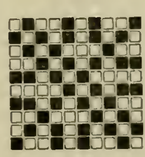

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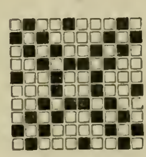

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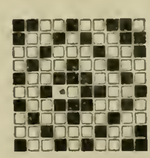

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10 HARNESS. 10 PICKS.

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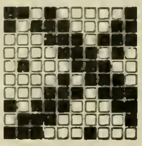
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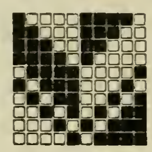
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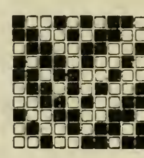
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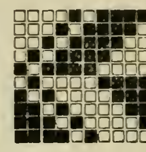
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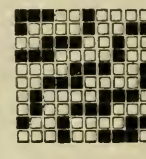
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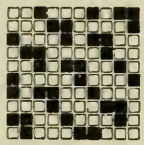
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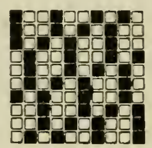
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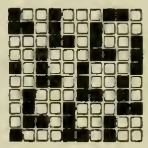
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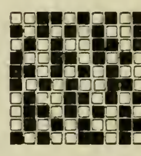
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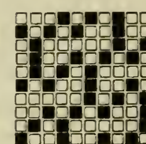
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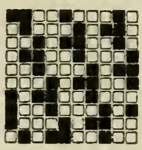
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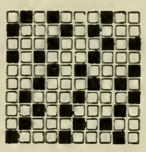
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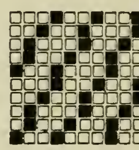
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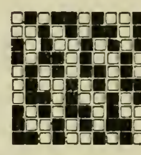
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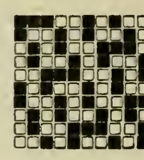
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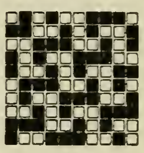
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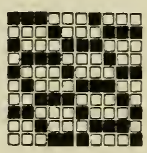
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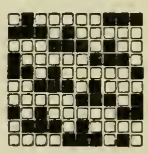
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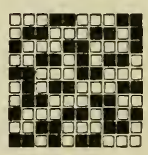
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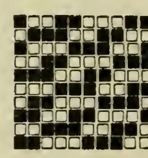
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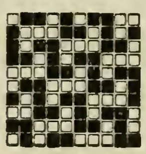
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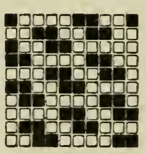
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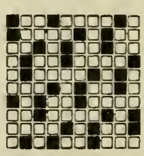
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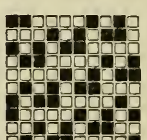
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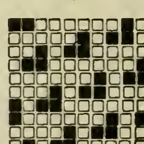
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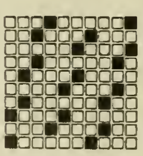
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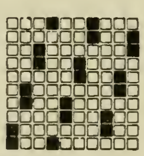
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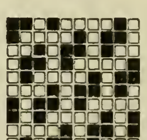
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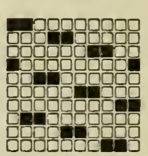
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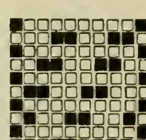

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10 HARNESS. 10 PICKS.

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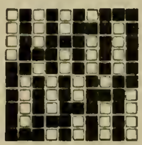

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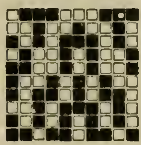

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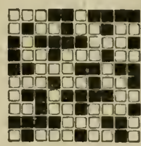

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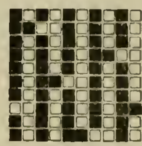

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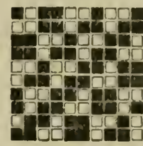

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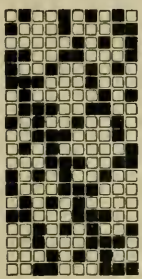

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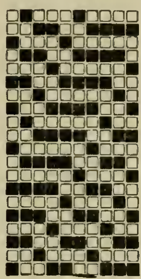

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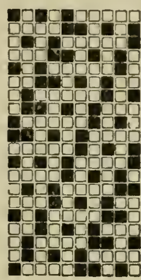

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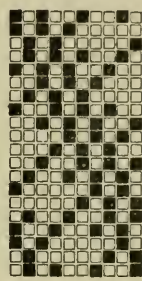

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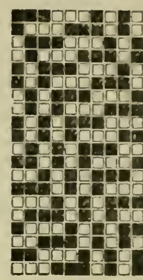

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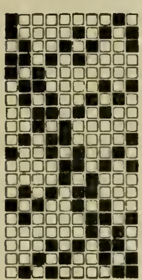

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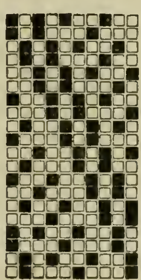

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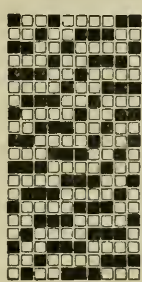

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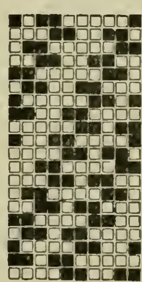

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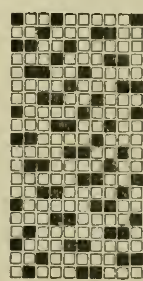

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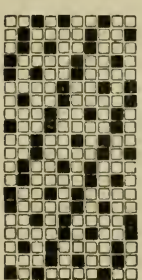

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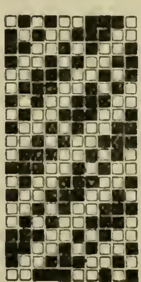

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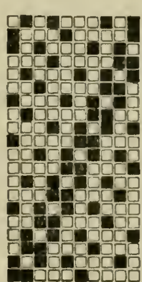

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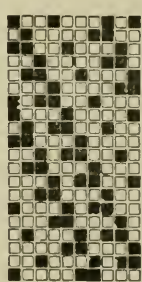

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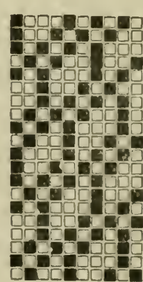

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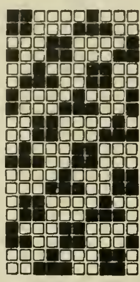

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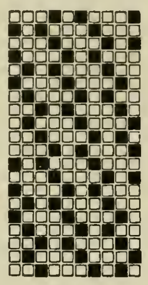

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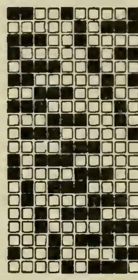

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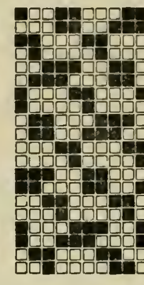

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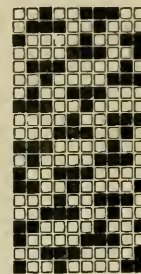

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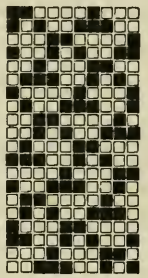

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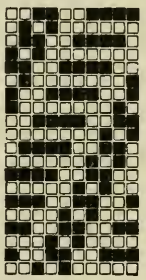

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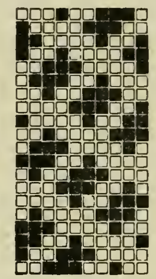

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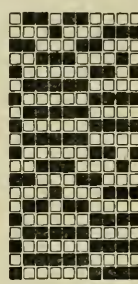

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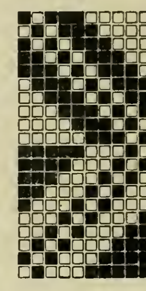

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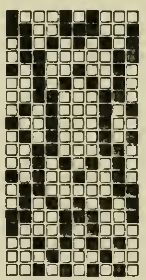

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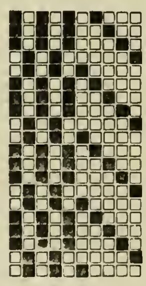

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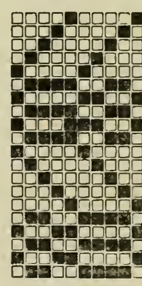

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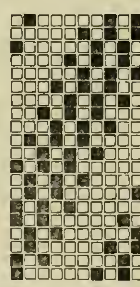

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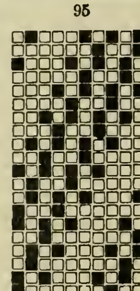

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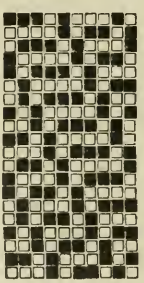

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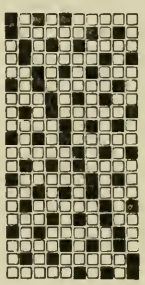

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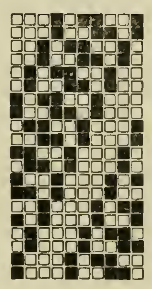

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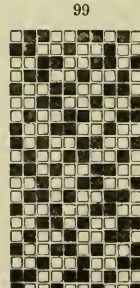

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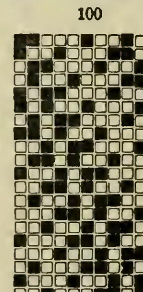

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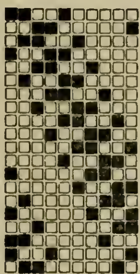

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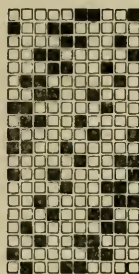

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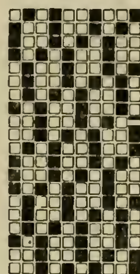

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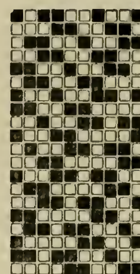

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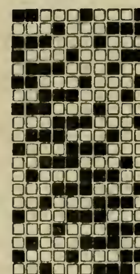

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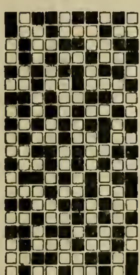

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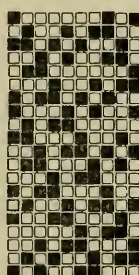

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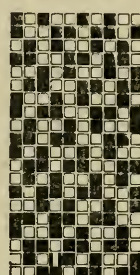

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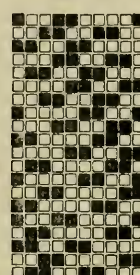

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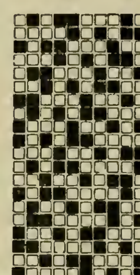

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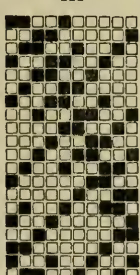

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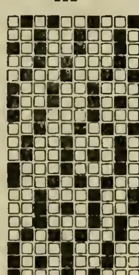

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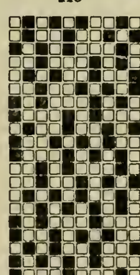

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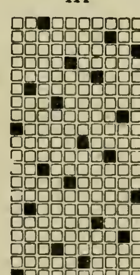

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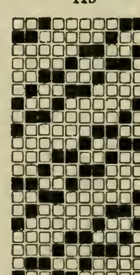

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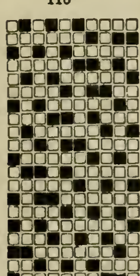

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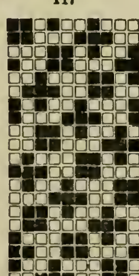

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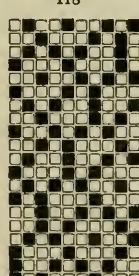

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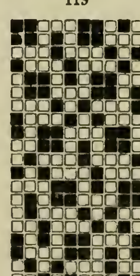

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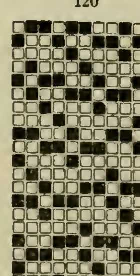

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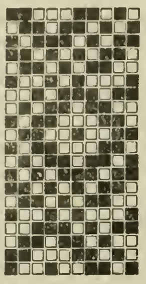

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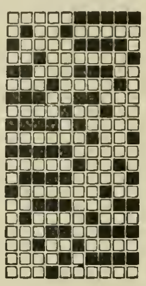

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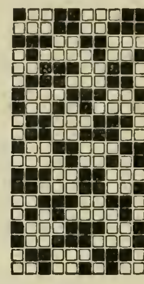

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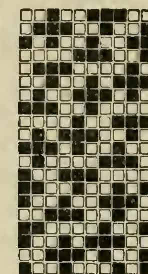

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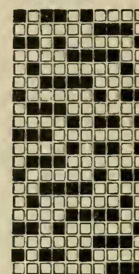

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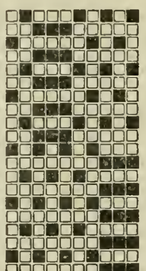

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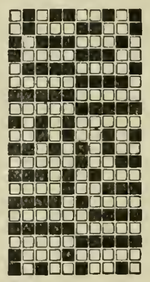

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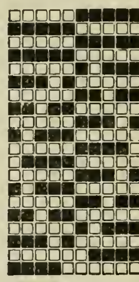

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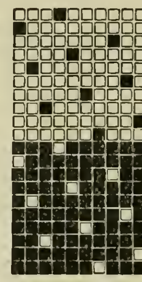

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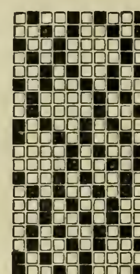

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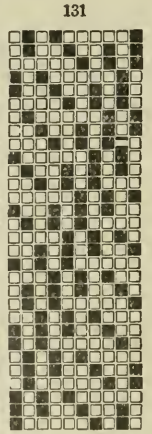

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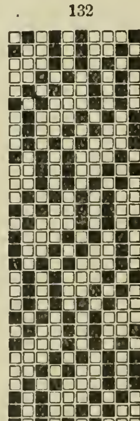

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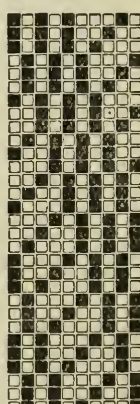

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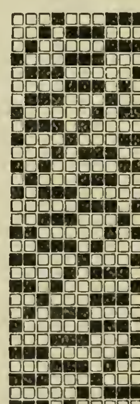

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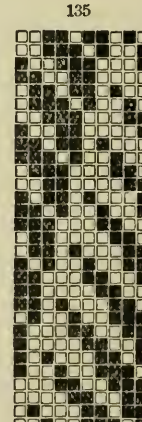

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10 HARNESS. 30 PICKS.

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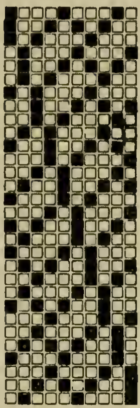

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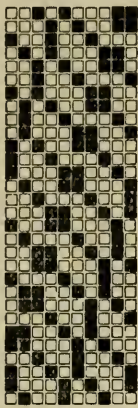

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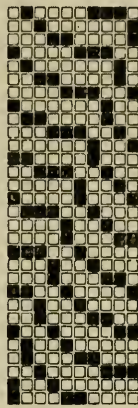

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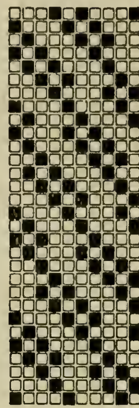

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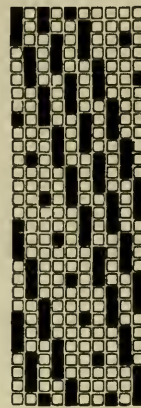

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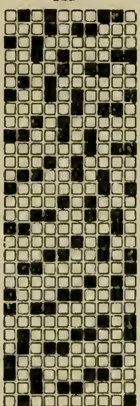

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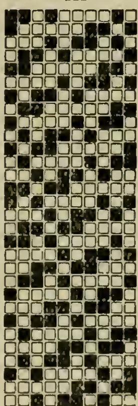

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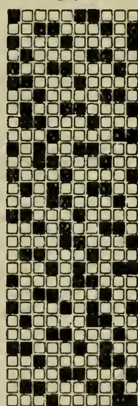

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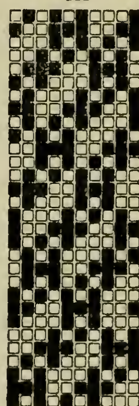

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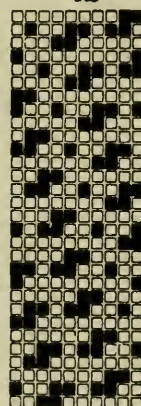

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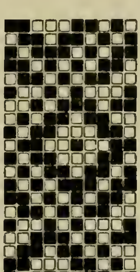

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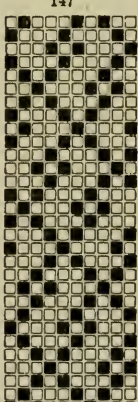

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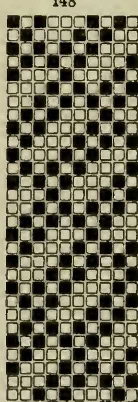

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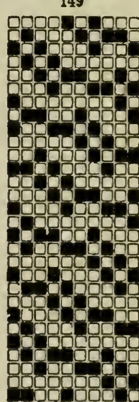

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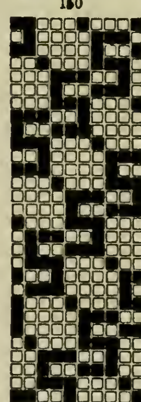

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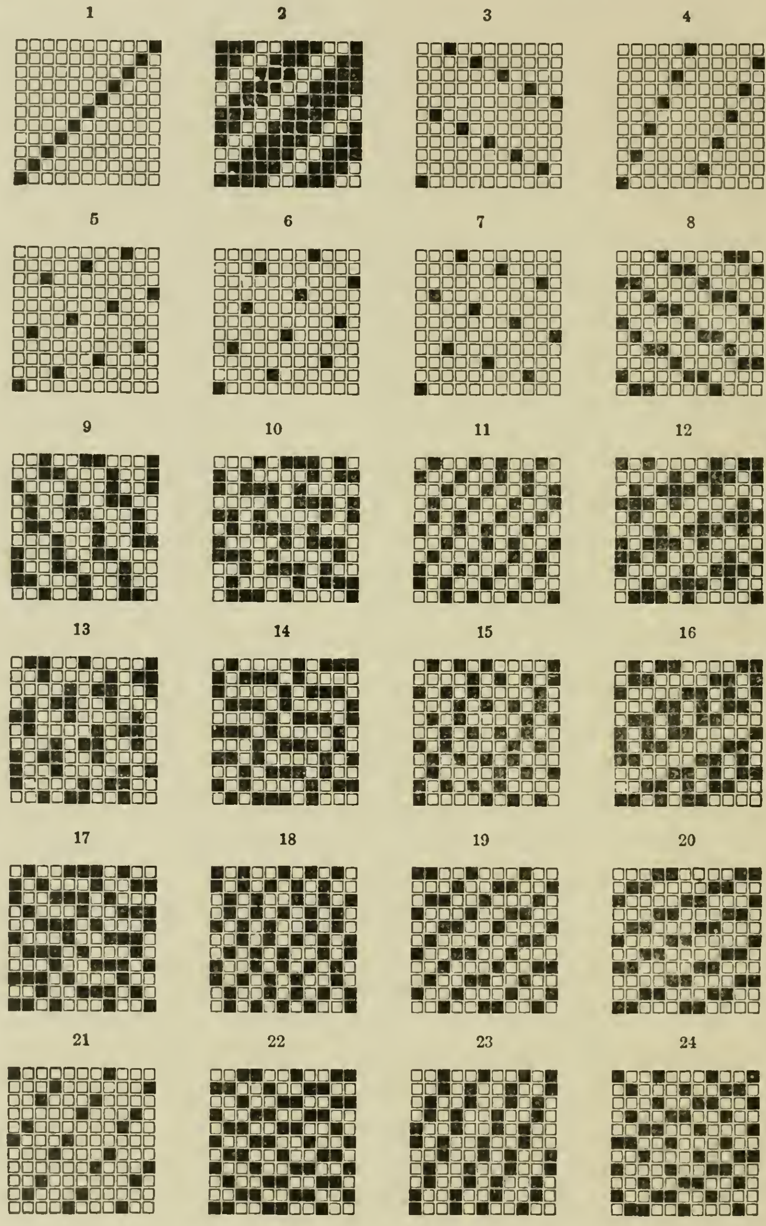

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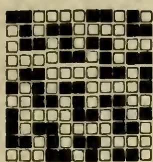

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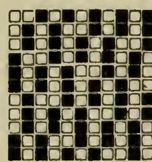

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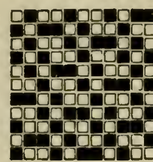

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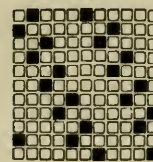

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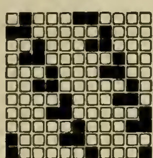

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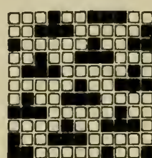

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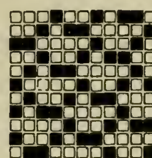

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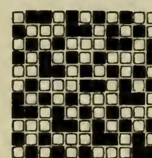

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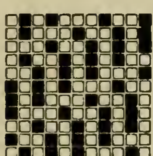

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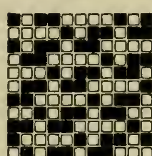

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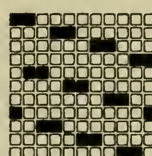

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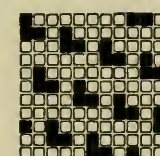

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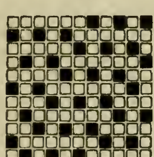

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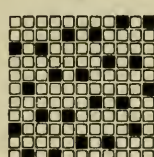

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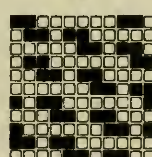

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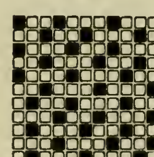

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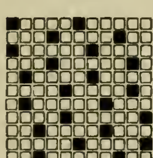

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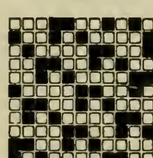

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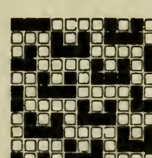

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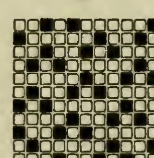

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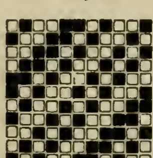

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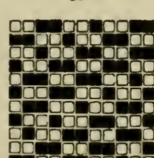

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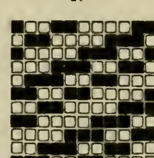

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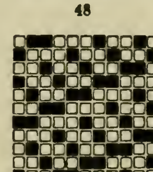

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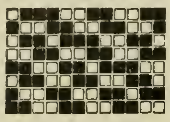
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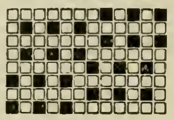
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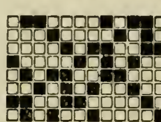
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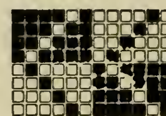
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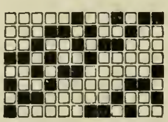
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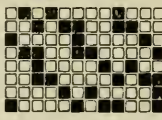
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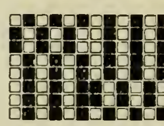
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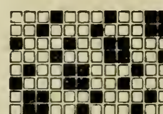

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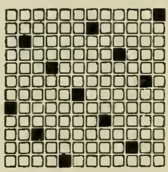
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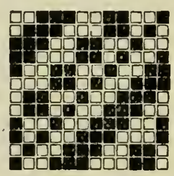
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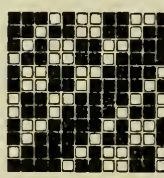
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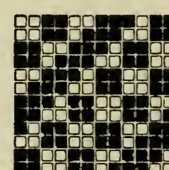
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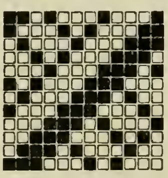
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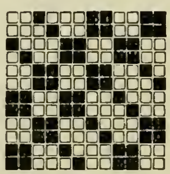
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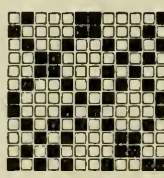
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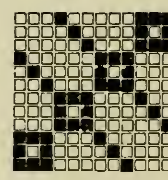
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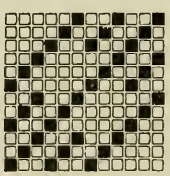
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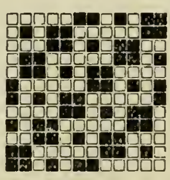
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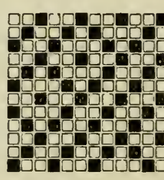
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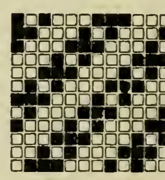
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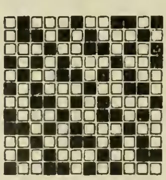
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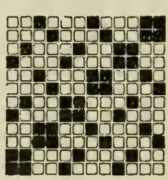
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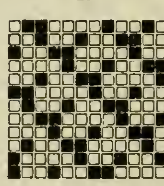
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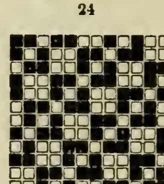

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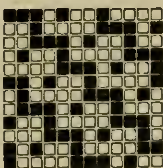
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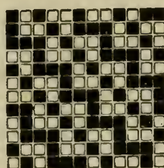
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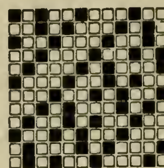
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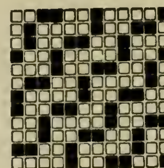
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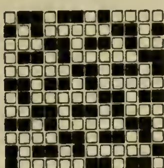
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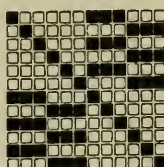
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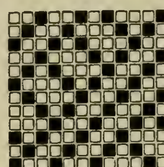
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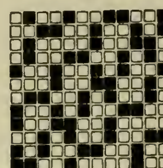
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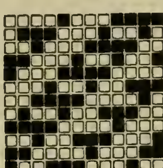
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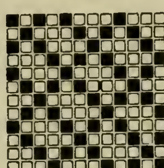
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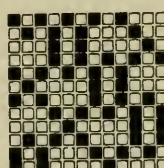
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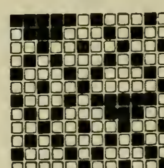
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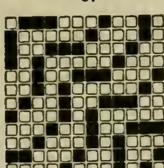
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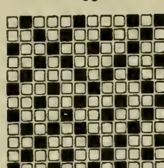
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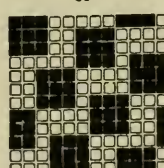
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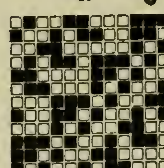
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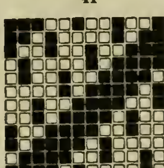
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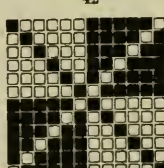
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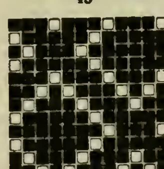
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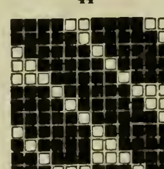
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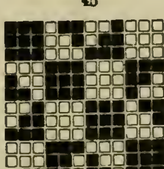
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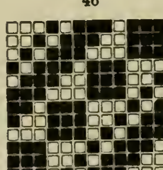
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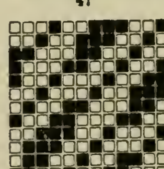
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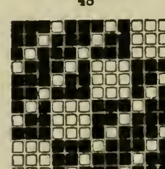

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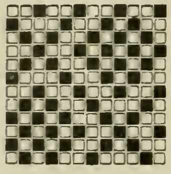
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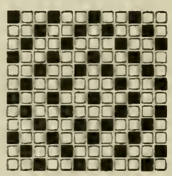
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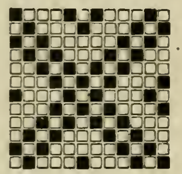
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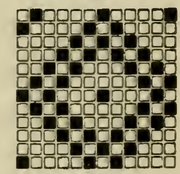

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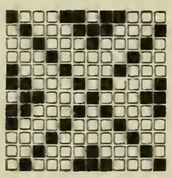
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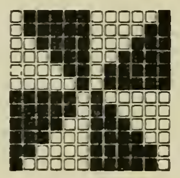
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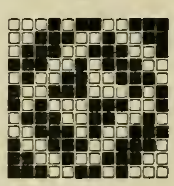
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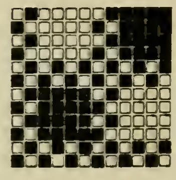

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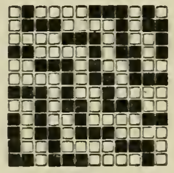
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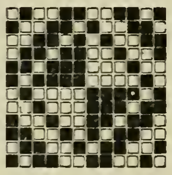
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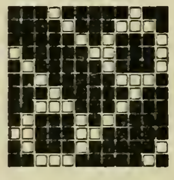
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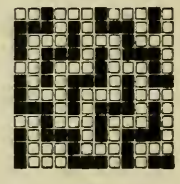

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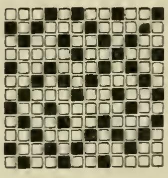
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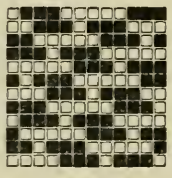
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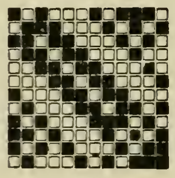
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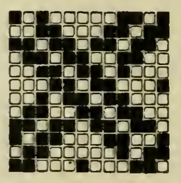

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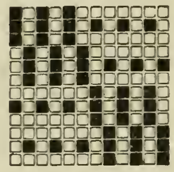
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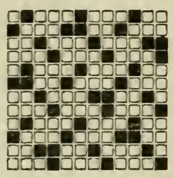
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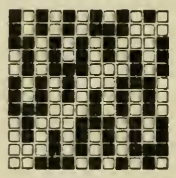
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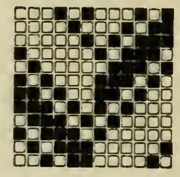

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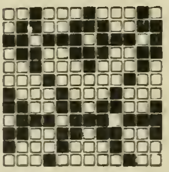
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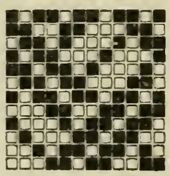
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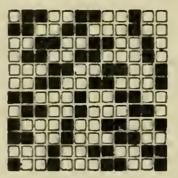
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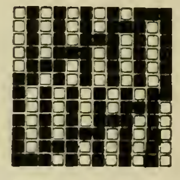

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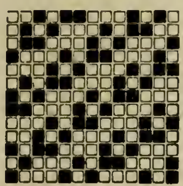
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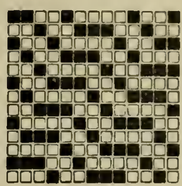
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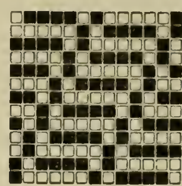
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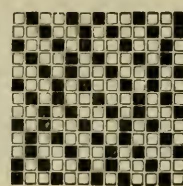
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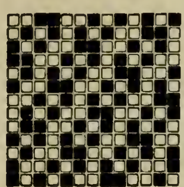
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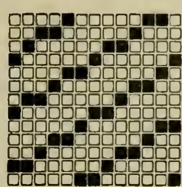
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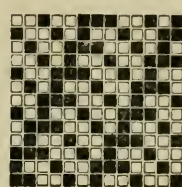
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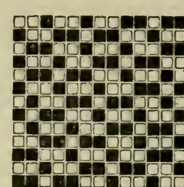
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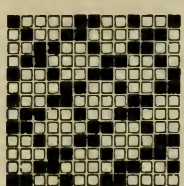
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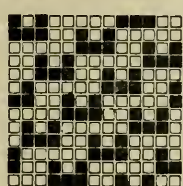
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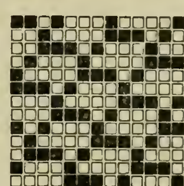
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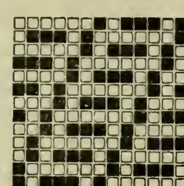
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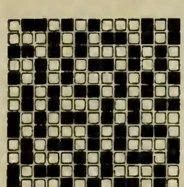
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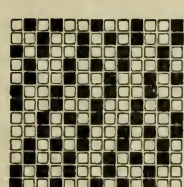
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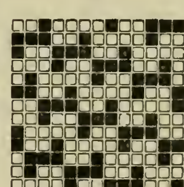
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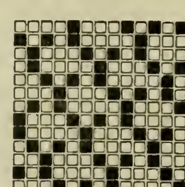
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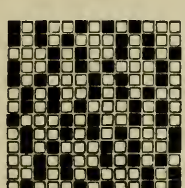
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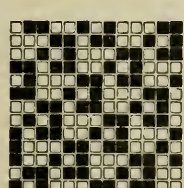
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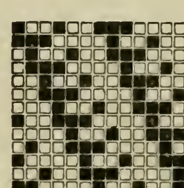
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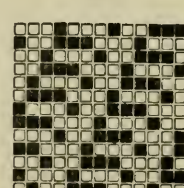

THE DISSECTION OF A FABRIC.

Textile design may be divided into two important parts, (*a*) designing, (*b*) dissection and analysis. Designing consists in the building of fabrics from designs more
1. or less original and the textures, weaves and colors are limited only by the yarns and looms under the designer's
control. Dissection differs radically from designing in 2.
that the designer must reproduce another's ideas, allowing but little originality.

In order to produce a perfect reproduction of a
3. fabric, two points should be considered ; first, a thorough knowledge of all branches of designing; second, a theory of the many calculations necessary, and the most expedient manner in which this theory may be given practical use.

Many designers perform their work without any attempt at method, causing great inconvenience to themselves, and resulting in a useless waste of material and
time. Judgment acquired by experience, and assisted 4.
by method in daily work, leads to economy which is one of the foundations to a successful career in mill life.

The principal facts necessary in the analysis of a fa-
5. bric to be reproduced, are, the nature of the fibre from which the yarn is spun, the quality of the yarn, the twist or turns per inch, the colors in a pattern, the weaves used to produce the desired effect and the character of the various finishing processes. These should be carefully ascertained in order that a perfect reproduction of the original fabric may be produced.

Previous to the dissection of a sample, the fabric 6.
should be classed, and the face back, warp and filling
7. determined. Fabrics are classed according to the purposes for which they are intended, and the principles used in the designing. Backed, double and triple cloths,
which are single cloths, increased in weight by the addi- 8.
tion of extra warps, fillings, or warps and fillings, are easily classified by their general appearance and weight. Single cloths presents but little difficulty, and may be classed as such at a glance.

Determining the face and back of the fabric often
requires considerable judgment and experience. The
9. face of the cloth is often napped, which affords one of
the best tests for determining the face. Another test is
the "draw" and "bite," caused by shearing which is
noticeable on the face of the fabric. The "draw" is the 10.
smooth feeling experienced when the fingers are passed
in the direction of the warp, and the "bite" is the slight
resistance encountered when the fingers are passed in
the opposite direction of the warp. Worsted dress
11. goods, and similar fabrics, are often confusing, the face
and back presenting almost the same appearance,
although but little difficulty should be experienced if the
"draw" and "bite" test is used. Union goods are gene-
rally woven with the animal fibres more prominent on the
face of the fabric. The face of double cloths woven by 12.
the so-called "two and one" method is finer than the
back, and generally worsted, while the back is a coarser
woolen fabric. Double cloths woven by the "one and
13. one" method are more difficult to determine, as the face
and back are usually of the same counts and grade of
yarns. The face yarns are often stronger and better,
and this fact often distinguishes the face from the back.
The "draw" test is perhaps, the best to use.

Warp is determined from filling in many ways. A portion of the selvedges in the sample decides the warp at once, but if the sample is cut so that no part of the selvedges is present, any of the following tests should be sufficient to determine the warp from the filling.

1. If the yarn is double and twist in one direction, 14.
and single the other, the twist yarn is the warp.

14. 2. Warp yarn is generally harder twist than filling
yarn.

3. Starched yarn, if only in one direction denotes 15.
the warp. Starch, or size, is applied to warp to
strengthen the yarn.

16. 4. Reed marks are always in the direction of the warp.

5. If the yarn is straigth and regular in one direction, and rough, loose and displaced the other, the straighter yarn will indicate the warp.

6. If one set of yarns is finer than the other, the finer yarn will usually be the warp. 16.

16. 7. Nap always runs in the direction of the warp.

16. 8. Stripes are generally formed by the warp.

9. Fabrics woven with yarns right twist in one direction, and left twist the other, invariably may be 14. considered as being woven from a right twisted warp.

Exceptions to these tests are seldom. Varying conditions arise in many fabrics, and the cause is generally so pronounced that little examination is required to determine the warp from the filling. Warp yarn is 17. usually finer, stronger, of better material, and harder twisted than filling yarn.

THE DISSECTION OF A FABRIC—QUESTION SHEET.

1. Define the term "designing."
2. How does dissection differs from designing?
3. What points should be considered when producing a perfect reproduction of a fabric?
4. What advantages are gained by method in designing?
5. Name the principle facts necessary in the analysis of a fabric.
6. What must be determined previous to the dissection of a sample?
7. How are fabrics classed?
8. How are backed, double and triple cloths classified?
9. How does the nap on the face of a fabric assist in analyzing?
10. Define the terms "bite" and "draw."
11. How is the face of worsted dress goods determined?
12. Describe the general appearance of union goods.
13. Compare the yarns in double cloths woven on the 1 and 1, and 2 and 1 systems.
14. How does the twist in a yarn assist in determining the warp or filling in a sample?
15. Does starch yarn denote the warp or filling?
16. Describe the following tests for warp or filling; reed marks; nap; stripes; counts of yarn.
17. How does warp yarn usually differ from filling yarn?

CLOTH ANALYSIS.

Date, October 26. 1903. *Name,* F. E. Sawyer.

Pattern No. 100

Fabric, Worsted Suiting

Data one square inch = 1.3 *grains.* *Width within selvedges, finished,* = 28"

72 *Threads per inch finished* = .7 *grains.* 60 *Picks per inch finished* = .6 *grains*

Total warp shrinkage, + 6 % *In weaving,* *In finishing,*

Total filling shrinkage, + 6 % *In weaving,* *In finishing,*

Add. for selvedge, to finished width, white 1" = 72 *threads.*

Remarks,

ANALYSIS.

1 *Weight of one yard inside selvedges,* 28 × 36 × 1.3 ÷ 437.5 = 2.995 oz

2 *Pick out.* 6 × 6. 3. *Drawing in draft and chain,*

4 *System or dressing of warp,*

White worsted	3	2	3	2	10	
Black	"	6		6	12	
Pink	"	1			1	
Yellow	"			1	1	24

5. *System or scheme of filling,*

Blue	"	6	6	
White	"	6	6	12

6 *Threads in warp,* 28 × 72 = 2016 7. *Threads in pattern,* 24 8. *Patterns in warp,* 2016 ÷ 24 = 84

9 *Size (counts, or run,) of warp in finished cloth,* 72 × 7000 ÷ .7 × 36 × 560 = 35.714

10 *Size, (counts, or run,) of filling in finished cloth,* 60 × 7000 ÷ .6 × 36 × 560 = 34.722

11 *Weight of warp yarn in one yard of finished cloth,*

White	10 × 84 =	840 × 16 ÷ 35.714 × 560 =	.672	
Black	12 × 84	1008 × 16 ÷ 35.714 × 560 =	.806	
Pink	1 × 84	84 × 16 ÷ 35.714 × 560 =	.067	
Yellow	1 × 84	84 × 16 ÷ 35.714 × 560 =	.067	1.612 oz

12 *Weight of filling yarn in one yard of finished cloth,*

	Blue	840 × 16 ÷ 34.722 × 560 =	.691	
60 × 28 = 1680	White	840 × 16 ÷ 34.722 × 560 =	.691	1.382
				2.994

RECONSTRUCTION.

13 *Width in loom, including selvedges,* 28 + 1 = 29 + 6% = 30.74

14. *Reed,* 2016 + 72 = 2088 ÷ 30.74 = 64.441

15 *Approximate size of original warp yarn, i. e. in loom,* 35.714 + 6% = 37.856

16. *Approximate size of original filling yarn, i. e. in loom,* 34.722 + 6% = 36.805

17 *Picks per inch in loom,* 60

18 *Weight of each color of warp yarn in loom, including selvedges,*

White	912 × 16 ÷ 37.856 × 560 = .688	+ 6% =	.729
Black	1008 × 16 ÷ 37.856 × 560 = .760	+ 6% =	.805
Pink	84 × 16 ÷ 37.856 × 560 = .063	+ 6% =	.067
Yellow	84 × 16 ÷ 37.856 × 560 = .063	+ 6% =	.067
			1.668 oz

19 *Weight of each color of filling yarn in loom, including selvedges,*

60 × 30.74 = 1844.4 ÷ 2 = 922.2	Blue	922.2 × 16 ÷ 36.805 × 560 =	.716
	White	922.2 × 16 ÷ 36.805 × 560 =	.716
			1.432

20 { *Weight of one yard of cloth in loom,* 1.668 + 1.432 = 3.100 oz

Proof, 29 × 36 × 1.3 ÷ 437.5 = 3.101

−.001

CLOTH ANALYSIS.

Date, October 1, 1905. *Name,* Charles Moody.

Pattern No. 116X.

Fabric, Worsted Dress Goods.

Data: one square inch = 2.7 *grains.* *Width within selvedges, finished,* = 39"

70 *Threads per inch finished* = 1.3 *grains* 38 *Picks per inch finished* = 1.4 *grains*

Total warp take up ~~shrinkage~~, 6% *In weaving,* *In finishing,*

Total filling take up ~~shrinkage~~, 6% *In weaving,* *In finishing,*

Add, for selvedge, to finished width, 1" = 70 Black *threads.*

Remarks,

ANALYSIS.

1. *Weight of one yard inside selvedges,* 39 x 36 x 2.7 ÷ 437.5 = 8.664 ounces.
2. *Pick out,*
3. *Drawing in draft and chain,*
4. *System or dressing of warp,*

Drab 13
Black 13

5. *System or scheme of filling,*

Red Twist 13
Green Twist 13

6. *Threads in warp,* 39×70=2730
7. *Threads in pattern,* 26
8. *Patterns in warp,* 2730×26=105
9. *Size, (counts, or run,) of warp in finished cloth,*

70×7000÷1.3×36×560=18.696

10. *Size, (counts, or run,) of filling in finished cloth,*

38×7000÷1.4×36×560= 9.424

11. *Weight of warp yarn in one yard of finished cloth,*

39×70×16÷18.696×560= 4.170 ounces

12. *Weight of filling yarn in one yard of finished cloth,*

39×38×16÷9.424×560 = 4.493 ounces

8.663 ounces.

RECONSTRUCTION.

13. *Width in loom, including selvedges,* 39+1=40+6%=42.4 inches.
14. *Reed,* 2730+70=2800÷42.4=66.035 threads per inch in loom 66.035÷2=33 reed.
15. *Approximate size of original warp yarn, i. e. in loom,* 18.696 + 6% = 19.817
16. *Approximate size of original filling yarn, i. e. in loom,* 9.424 + 6% = 9.989
17. *Picks per inch in loom,* 38
18. *Weight of each color of warp yarn in loom, including selvedges,*

Drab 13×105×16÷19.817×560=1.968+6%=2.086 ounces.
Black 13×105+70×16÷19.817×560=2.068+6%=2.192 "

19. *Weight of each color of filling yarn in loom, including selvedges,*

38×42.4=1611.2 Green 805.6×16÷9.989×560=2.304 ounces.
Red 805.6×16÷9.989×560=2.304 "

20. { *Weight of one yard of cloth in loom,* 40×36×2.7÷437.5 = 8.886 ounces
Proof, 2.086+2.192+2.304+2.304 = 8.886 "

CLOTH ANALYSIS.

Date, September 12, 1901 *Name*, Charles Moody.

Pattern No. 103.5

Fabric, Cotton Gingham.

Data : one square inch = 1.35 grains. *Width within selvedges, finished*, = 27 inches

64 *Threads per inch finished* = .8 grains 54 *Picks per inch finished* = .55 grains

Total warp ~~*shrinkage*~~ take up, + 8% *In weaving*, — *In finishing*, —

Total filling ~~*shrinkage*~~ take up. + 6% *In weaving*, — *In finishing*, —

Add. for selvedge, to finished width. 1/2 inch = 32 (white) *threads.*

Remarks,

ANALYSIS.

1 *Weight of one yard inside selvedges*, 27 × 36 × 1.35 ÷ 437.5 = 2.999 oz.

2. *Pick out*, a Plain weave. 3. *Drawing in draft and chain*, —

4 *System or dressing of warp*,

White	2 2		4	
Yellow	4		4	
Black	4 4		8	
Red	2		2	18 total

5 *System or scheme of filling*,

Same as warp

6 *Threads in warp*, 27 × 64 = 1728 7 *Threads in pattern*, 18. 8. *Patterns in warp*, 1728 ÷ 18 = 96.

9. *Size, (counts, or run,) of warp in finished cloth*,

64 × 7000 ÷ 36 × .8 × 840 = 18.518

10. *Size, (counts, or run,) of filling in finished cloth*,

54 × 7000 ÷ 36 × .55 × 840 = 22.727

11. *Weight of warp yarn in one yard of finished cloth*,

64 × 27 × 16 ÷ 18.518 × 840 = 1.777 oz

12. *Weight of filling yarn in one yard of finished cloth*,

54 × 27 × 16 ÷ 22.727 × 840 = 1.221 oz

2.998 oz. total

RECONSTRUCTION.

13. *Width in loom, including selvedges*, 27 + .5 = 27.5 + 6% = 29.15 inches

14. *Reed*, 1728 + 32 = 1760 = 1760 ÷ 29.15 = 60.377 {threads per inch in loom 60.377 ÷ 2 = 30.188 30/2 reed.

15. *Approximate size of original warp yarn, i. e. in loom*, 18.518 + 8% = 19.999

16. *Approximate size of original filling yarn, i. e. in loom*, 22.727 + 6% = 24.090

17. *Picks per inch in loom*, 54

18. *Weight of each color of warp yarn in loom, including selvedges*, White Ends 416 × 16 ÷ 19.999 × 840 = .3962 + 8% = .4278 oz

Yellow 384 × 16 ÷ 19.999 × 840 = .3657 + 8% = .3949

Black 768 × 16 ÷ 19.999 × 840 = .7314 + 8% = .7899

Red 192 × 16 ÷ 19.999 × 840 = .1828 + 8% = .1974 1.810

19. *Weight of each color of filling yarn in loom, including selvedges*, White (87.45 × 4) × 16 ÷ 24.09 × 840 = .276 oz

54 × 29.15 = 1574.1 ÷ 18 = 87.45 Yellow (87.45 × 4) × 16 ÷ 24.09 × 840 = .276

Black (87.45 × 8) × 16 ÷ 24.09 × 840 = .553

Red (87.45 × 2) × 16 ÷ 24.09 × 840 = .138 1.243

20. { *Weight of one yard of cloth in loom*, 1.810 + 1.243 = 3.053 oz

Proof, 27.5 × 36 × 1.35 ÷ 437.5 = 3.054 =

Proof .001 oz heavy

CLOTH ANALYSIS.

Date, November 1, 1904 *Name,* Charles Moody.

Pattern No. 117.

Fabric, Worsted Dress Goods.

Data: one square inch = 1.8 *grains.* *Width within selvedges, finished,* = 28"

27 *Threads per inch finished* = *grains.* 30 *Picks per inch finished* = *grains*

Total warp ~~*shrinkage*~~ take up, + 10% *In weaving,* — *In finishing,* —

Total filling ~~*shrinkage*~~ take up, + 10% *In weaving,* — *In finishing,* —

Add, for selvedge, to finished width, = *threads.*

Remarks, 106 inches black (warp or filling) = 4.4 grains
111 inches blue (warp or filling) = 2.4 grains.

ANALYSIS.

1. *Weight of one yard inside selvedges,* 28 × 36 × 1.8 ÷ 437.5 = 4.147 ounces.
2. *Pick out,* 12 × 12
3. *Drawing in draft and chain,* Straight on 12 harnesses.
4. *System or dressing of warp,*

Black 6 = 6
Blue 6 = 6 12.

5. *System or scheme of filling,*

Same as warp.

6. *Threads in warp,* 27 × 28 = 756.
7. *Threads in pattern,* 12
8. *Patterns in warp,* 756 ÷ 12 = 63.
9. *Size, (counts, or run,) of warp in finished cloth,* Black 106 × 7000 ÷ 4.4 × 36 × 560 = 8.364
Blue 111 × 7000 ÷ 2.4 × 36 × 560 = 16.059
10. *Size, (counts, or run,) of filling in finished cloth,* Black 106 × 7000 ÷ 4.4 × 36 × 560 = 8.364
Blue 111 × 7000 ÷ 2.4 × 36 × 560 = 16.059
11. *Weight of warp yarn in one yard of finished cloth,*
Black 6 × 63 × 16 ÷ 8.364 × 560 = 1.291
Blue 6 × 63 × 16 ÷ 16.059 × 560 = .672 1.963 oz.
12. *Weight of filling yarn in one yard of finished cloth,*
30 × 28 = 840 ÷ 12 = 70 patterns Black 6 × 70 × 16 ÷ 8.364 × 560 = 1.434
Blue 6 × 70 × 16 ÷ 16.059 × 560 = .747 2.181
4.144 oz

RECONSTRUCTION.

13. *Width in loom, including selvedges,* 28 + 1 = 29 × 1.10 = 31.9 inches
14. *Reed,* 756 + 27 = 783 ÷ 31.9 = 24.545 ÷ 2 = 12.27
15. *Approximate size of original warp yarn, i. e. in loom,* Black 8.364 × 1.10 = 9.200 Blue 16.059 × 1.10 = 17.664
16. *Approximate size of original filling yarn, i. e. in loom,* Black 8.364 × 1.10 = 9.200 Blue 16.059 × 1.10 = 17.664
17. *Picks per inch in loom,* 30
18. *Weight of each color of warp yarn in loom, including selvedges,*
783 ÷ 2 = 391.5 Black 392 × 16 ÷ 9.200 × 560 = 1.217 × 1.10 = 1.339 oz.
Blue 391 × 16 ÷ 17.664 × 560 = .632 × 1.10 = .695
1.849 2.034 oz.
19. *Weight of each color of filling yarn in loom, including selvedges,*
31.9 × 30 = 957 ÷ 2 = 478.5 Black 478.5 × 16 ÷ 9.200 × 560 = 1.486 oz.
Blue 478.5 × 16 ÷ 17.664 × 560 = .774
2.260
20. { *Weight of one yard of cloth in loom,* 2.034 + 2.260 = 4.294 oz.
{ *Proof,* 29 × 36 × 1.8 ÷ 437.5 = 4.295 oz.

ANALYSIS—COTTON GINGHAM.

DATA :— 1 square inch weighs 1.35 grains; width, inside selvedges, finished, 27. inches; 64 threads per inch finished weigh, .8 grains; 54 picks per inch finished weigh, .55 grains; warp take-up, 8%; filling take-up, 6%. Add one-half inch, 32 white threads, to finished width for selvedges.

1. Weight, in ounces, of one yard of finished cloth, inside selvedges.

(*a*). Find the number of square inches in one yard of finished cloth by multiplying the width in inches by the number of inches in one yard.

One yard of the fabric analyzed is 27 inches wide, and one yard or 36 inches long.

$$27 \times 36 = 972 \text{ square inches in one yard.}$$

(*b*). The number of square inches in one yard of cloth multiplied by the weight of one square inch in grains will give the weight of one yard of finished cloth in grains.

Square inches in one yard of cloth, 972; weight of one square inch, 1.35 grs.

$$972 \times 1.35 = 1312.2 \text{ grains.}$$

(*c*). To find the weight in ounces divide the weight of one yard of cloth in grains by the number of grains in one ounce.

$$7000 \text{ grains} = 1 \text{ pound.} \qquad 16 \text{ ounces} = 1 \text{ pound.}$$
$$7000 \div 16 = 437.5 \text{ ounces in 1 pound.}$$

Weight in grains of 1 yard, 1312.2. Grains in 1 ounce, 437.5.

$$1312.2 \div 437.5 = 2.999 \text{ ounces.}$$

FORMULA:—(Width in inches $\times$ length in inches $\times$ weight of one square inch in grains) $\div$ (grains in one ounce) = weight of one yard of finished cloth in ounces.

2. Pick out.

Designate the size of one complete repeat of the weave giving the number of threads first and then the number of picks, thus :

$$4 \times 4$$

When a simple weave is used in the fabric the name of the weave is generally given, thus :

Plain weave.

3. Drawing in draft and chain.

Designate the number of harnesses required and the style of draft, thus:

4 harness, straight over.

4. System, or dressing of warp.

The dressing of a pattern should be given in detail.

White cotton	2	2				4
Yellow cotton			4			4
Black cotton				4	4	8
Red cotton					2	2
						— 18

5. System, or scheme of filling.

The same principles are used here as in question 4.

When the filling pattern is the same as the warp pattern the term "same as warp" is used.

When either the warp or filling is one color the term "solid" is used, followed by the color, such as solid white.

6. Threads in warp.

To find the number of threads in warp multiply the threads in one inch by the width in inches.

Threads in one inch, 64. Width in inches, 27.

$64 \times 27 = 1728$ threads in warp.

FORMULA: Threads per inch finished $\times$ finished width in inches = threads in warp.

NOTE: All calculations in the Analysis section of a sheet are figured inside selvedges.

7. Threads in pattern.

The number of threads in a pattern is found in question 4.

18 threads in a pattern.

8. Patterns in warp.

To find the number of patterns in a warp, divide the total threads in warp, inside selvedges, by the threads in a pattern.

Threads in warp, 1728. Threads in pattern, 18.

$1728 \div 18 = 96$ patterns in warp.

FORMULA: Threads in warp $\div$ threads in pattern = patterns in warp.

As many warps are dressed in sections the patterns in warp should be divisable by three or more numbers to allow for complete repeats of the pattern in each section. This rule generally applies to woolen or worsted warps. In this cloth there are 96 patterns of 18 threads, and the warp may be divided into three sections of 576 threads, 4 sections of 432 threads or 6 sections of 288 threads. If 97 patterns were used the warp could not be divided into sections containing complete patterns in each section, tending to produce an imperfect dressing in the warp when placed in the loom.

9. Size (counts or run) of warp in finished cloth.

(*a*). Find the weight in grains of one yard of No. 1 counts of the required class of yarn by dividing the number of grains in one pound by the number of yards in No. 1 yarn in one pound (cotton 840).

Grains in one pound, 7000. Yards No. 1 cotton in one pound, 840.

$7000 \div 840 = 8.333$ grains weight of 1 yard No. 1 cotton.

(*b*). Find the weight in grains of the given number of inches of No. 1 yarn (first reducing the number of given inches to yards) by multiplying the weight in grains of one yard of No. 1 by the given number of yards of yarn.

Given number of inches, 64. Inches in one yard, 36.

$64 \div 36 = 1.777$ yards of given yarn.

Weight of one yard of No. 1 cotton, 8.333 grains. Given yards of yarn, 1.777.

$8.333 \times 1.777 = 14.8077$ grains weight of given length of No. 1 yarn.

14.8077 grains is the weight of the given length (1.777 yards) of No, 1 yarn and .8 grains the weight of the same length of the required yarn. The counts of the required yarn is equal to the number of times greater the weight of No. 1 yarn is than the weight of the required yarn; therefore,

(*c*). To find the counts of the required yarn divide the weight of the given length of No. 1 yarn by the weight of the same length of required yarn.

Weight of 1.777 yards of No. 1 yarn, 14.8077 grains; weight of 1.777 yards of required yarn, .8 grains.

$$14.8077 \div .8 = 18.509 \text{ counts of warp.}$$

FORMULA: (Given inches of yarn $\times$ grains in one pound) $\div$ (given weight of yarn $\times$ inches in one yard $\times$ standard number of required yarn) = counts of required yarn.

$$64 \times 7000 \div .8 \times 36 \times 840 = 18.518.$$

Any variation in the results of calculations is due to limiting the work to the third decimal point.

10. Size (counts or run) of filling in finished cloth.

The same principles are used here as in question 9, substituting given filling data of number of inches and weight in grains for the warp data.

The calculations are as follows:

(*a*). Yards of No. 1 cotton in one pound, 840. Grains in one pound, 7000.

$$7000 \div 840 = 8.333 \text{ grains.}$$

(*b*). Given number of inches, 54. Inches in one yard, 36.

$$54 \div 36 = 1.5 \text{ yards given length.}$$

$8.333 \times 1.5 = 12.499$ grains weight of given length of No. 1 yarn.

(*c*) Weight of 1.5 yards of No. 1 cotton, 12.499 grains. Weight of 1.5 yards required yarn, .55 grains.

$$12.499 \div .55 = 22.727 \text{ required counts.}$$

FORMULA: Same as that used for question 9.

$$54 \times 7000 \div .55 \times 36 \times 840 = 22.727.$$

11. Weight of warp yarn in one yard of finished cloth.

(*a*). Find the number of yards of warp yarn in one pound by multiplying the number of yards of No 1 yarn in one pound (standard number) by the counts.

Standard number (cotton), 840. Counts of warp yarn, 18.518.

$840 \times 18.518 = 15555.12$ yards of 18.518 cotton in one pound.

NOTE: The counts of the yarn designates the number of hanks in one pound. The standard number is the number of yards in one hank.

(*b*). Find the number of yards of warp yarn in one yard of cloth by multiplying the threads per inch by the width in inches.

Threads per inch, 64. Width in inches, 27.

$64 \times 27 = 1728$ yards of warp yarn in one yard of cloth.

(*c*). Divide the number of yards of warp yarn in one yard of cloth (b) by the number of yards of warp yarn in one pound (a). This will give the weight in pounds of warp yarn in one yard of cloth.

Yards of warp yarn in one yard of cloth, 1728; yards of warp yarn in one pound, 15555.12.

$1728 \div 15555.12 = .111$ pounds of warp yarn in one yard of cloth.

(*d*). To find the weight in ounces multiply the weight in pounds by the number of ounces in one pound.

Weight in pounds of warp in one yard of cloth, .111. Ounces in one pound, 16.

$.111 \times 16 = 1.776$ ounces of warp yarn in one yard of cloth.

FORMULA: (Threads per inch finished $\times$ width in inches finished $\times$ ounces in one pound) $\div$ (counts $\times$ standard number) = weight in ounces of warp yarn in one yard of finished cloth.

$$64 \times 27 \times 16 \div 18.518 \times 840 = 1.777 \text{ ounces.}$$

NOTE: The above applies only when the warp yarn is the same in counts. When the warp yarn varies each counts must be figured according to the data for length and weight.

To find the weight of each counts of yarn the number of threads of each counts in a pattern is multiplied by the number of patterns in warp giving the number of yards of each counts of yarn in one yard of cloth. The weight in ounces of each kind of yarn is found by the formula previously given.

12. Weight of filling yarn in one yard of finished cloth.

The principles used here are the same as in question 11 substituting filling data for warp.

(*a*). Counts of filling yarn, 22.727. Standard number (cotton), 840.

$840 \times 22.727 = 19090.68$ yards of filling yarn in one pound.

(*b*). Picks per inch finished, 54. Width in inches, 27.

$54 \times 27 = 1458$ yards of filling yarn in one yard of cloth.

NOTE: 54 picks per inch equals 54 inches of filling in one inch. In one running inch across the cloth (27 inches wide) there are (54 x 27) 1458 inches of filling. In one yard of cloth (36 inches) there are (36 x 1458) 42488 inches of filling in one yard of cloth. To find the number of yards of filling divide by 36 (inches in one yard).

$$42488 \div 36 = 1458 \text{ yards.}$$

FORMULA: (Picks per inch x width in inches x length of one yard in inches) $\div$ inches in one yard = yards of filling in one yard of cloth.

$$54 \times 27 \times 36 \div 36 = 1458.$$

This formula may be simplified by cancelling both 36, giving as the general formula:

Picks per inch x width in inches = yards of filling yarn in one yard of cloth.

(*c*). Yards of filling yarn in one yard of cloth, 1458. Yards of filling yarn in one pound, 19090.68.

$$1458 \div 19090.68 = .0763 \text{ pounds.}$$

(*d*). Weight in pounds of filling yarn, .0763. Ounces in one pound, 16

.0763 x 16 = 1.2208 ounces of filling in one yard of finished cloth.

FORMULA: (Picks per inch x width in inches x ounces in one pound) ÷ (counts x standard number) = weight in ounces of filling yarn in one yard of finished cloth.

54 x 27 x 16 ÷ 22.727 x 840 = 1.221 ounces.

The weights found in questions 11 and 12 should equal the weight found in question 1.

Question 11.	Warp weight,	1.777.
Question 12.	Filling weight,	1.221.
	Total,	2.998 oz.
Question 1.	Weight of one yard,	2.999 oz.
	Proof (light),	.001

When the filling yarn varies in counts the process explained in the note to question 11 is used.

RECONSTRUCTION.

(13). Width in loom, including selvedges.

(*a*). Find the width of finished cloth including selvedges by adding the width of the selvedges to the finished width.

Finished width, 27 inches. Width of selvedges, ½ inch.

27 + ½ = 27½ or 27.5 inches.

(*b*). Find the width in loom by adding the filling take up to the finished width including selvedges.

27.5 + 6% = 29.15 inches loom width.

NOTE: The width of the cloth is affected by the filling take up and the difference or loss in width is the percentage expressed by the filling take up. The finished width is considered as 100% and the loom width 100% + the filling percentage. In this cloth the loom width should be 100% + 6% (filling take up) or 106% of the finished width.

FORMULA: (Finished width plus selvedges) x (100% plus filling take up) = loom width.

27.5 x 1.06 = 29.15 loom width.

14. Reed.

(*a*). Find the total threads in warp including selvedges by multiplying the threads per inch in finished cloth by the finished width, including selvedges.

Finished threads per inch, 64. Finished width including selvedges, 27½ inches.

27.5 x 64 = 1760 threads in warp.

(*b*). Divide the total number of threads in warp by the loom width to find the number of threads per inch in loom.

Total threads in warp, 1760. Loom width, 29.15 inches.

$1760 \div 29.15 = 60.377$ threads per inch in loom.

(*c*). Find the number of the reed by dividing the number of the threads per inch in loom by the number of threads in a dent.

Threads per inch in loom, 60.377. Threads in a dent, 2.

$60.377 \div 2 = 30.189$ reed.

This reed is expressed $^{30}/_{2}$ the 30 representing the reed and the 2 the number of threads in a dent.

FORMULA: (*a*). Finished width including selvedges x threads per inch finished = total threads in warp.

(*b*). Total threads in warp ÷ loom width = threads per inch in loom.

(*c*). Threads per inch in loom ÷ threads in a dent = number of reed.

15. Approximate size or original warp yarn *i. e.*, in loom.

The diameter of the warp yarn decreases from the finished cloth to the loom, according to the take up, or stretch of the warp. The number representing the counts of the yarn increases in proportion to the decrease in the diameter of the yarn.

(*a*). Find the approximate size of the warp yarn by adding the warp take up to the finished warp counts, or multiply the finished warp counts by 100% plus the warp take up.

Finished warp counts, 18.518. Warp take up, 8%.

$18.518 \times 1.08 = 19.999$, approximately 20.

FORMULA: Finished warp counts x (100% plus warp take up) = warp counts in loom.

16. Approximate size of original filling yarn, *i. e.*, in loom.

The filling take up affects the diameter and counts of the finished filling yarn in the same manner that the warp take up affects the warp yarn.

(*a*). Find the approximate size of filling yarn by adding the filling take up to the finished filling counts or multiply the finished filling counts by 100% plus the filling take up.

Finished filling counts, 22.727. Filling take up, 6%.

$22.727 \times 1.06 = 24.090.$

FORMULA: Finished filling counts x (100% plus the filling take up) = loom counts of filling.

7. Picks per inch in loom.

In a "take up" sheet the picks per inch finished and in loom are approximately the same.

Picks per inch in loom, 54.

8. Weight of each color of warp yarn in loom, including selvedges.

The weight of warp yarn in loom is found according to the instructions given in the note to question 11 substituting the loom counts for the finished counts, and using the total number of threads in warp.

(*a*). Find the number of yards in one pound of warp yarn.

Counts of yarn in loom, 19.999. Standard number (cotton), 840.

19.999 x 840 = 16799.16 yards warp yarn in one pound.

(*b*). Find the number of yards of each color in one yard of warp yarn in loom by multiplying the number of threads of each color in a pattern by the number of patterns in warp.

Patterns in warp, 96.

Threads of each color in a pattern:

White, 4; yellow, 4; black, 8; red, 2.

4 x 96 = 384 yards of white.
4 x 96 = 384 yards of yellow.
8 x 96 = 768 yards of black.
2 x 96 = 192 yards of red.

Add the selvedges to the required color (white).

384 + 32 = 416 yards of white.

(*c*). Find the weight in pounds of each color of warp yarn in one yard in loom by dividing by the number of yards of warp yarn in one pound.

White,	416 ÷ 16799.16 = .0247 lbs.
Yellow,	384 ÷ 16799.16 = .0228 lbs.
Black,	768 ÷ 16799.16 = .0457 lbs.
Red,	192 ÷ 16799.16 = .0114 lbs.
	1.046

(*d*). Find the weight in ounces of each color by multiplying the respective weights by the number of ounces in 1 pound.

Ounces in 1 pound, 16.

Weight of white warp,	.0247 pounds.
Weight of yellow warp,	.0228 pounds.
Weight of black warp,	.0457 pounds.
Weight of red warp,	.0114 pounds.

White,	.0247 x 16 = .3952 ounces.
Yellow,	.0228 x 16 = .3648 ounces.
Black,	.0457 x 16 = .7312 ounces.
Red,	.0114 x 16 = .1824 ounces.
	1.6736 ounces.

(*e*). These weights are for the yarn upon the warp beam. To find the weight of each color in the woven cloth add the warp take up to each.

White,	.3952 x 1.08 = .4268 ounces.
Yellow,	.3648 x 1.08 = .3939 ounces.
Black,	.7312 x 1.08 = .7897 ounces.
Red,	.1824 x 1.08 = .1970 ounces.

FORMULA: (Threads of each color in pattern x patterns in warp x ounces in one pound) ÷ (loom counts x standard number) = weight of each color in one yard in loom (on warp beam). Adding to this the warp take up = weight of each color in one yard in loom (woven on cloth roll).

White,	(96 x 4 + 32) x 16 ÷ 19.999 x 840 =	.396 ounces.
Yellow,	96 x 4 x 16 ÷ 19 999 x 840 =	.365 ounces.
Black,	96 x 8 x 16 ÷ 19.999 x 840 =	.731 ounces.
Red,	96 x 2 x 16 ÷ 19.999 x 840 =	.182 ounces.

White,	.396 x 1.08 =	.428 ounces.
Yellow,	.365 x 1.08 =	.395 ounces.
Black,	.731 x 1.08 =	.790 ounces.
Red,	.182 x 1.08 =	.197 ounces.
		1 810 ounces woven.

The selvedges should be added to the required color.

19. Weight of each color of filling yarn in loom, including selvedges.

(*a*). Find the number of yards of filling yarn in one pound.

Loom counts of filling, 24.090. Standard number (cotton), 840.

24.090 x 840 = 20235.6 yards of filling yarn in one pound.

(*b*). Find the number of yards of filling yarn in one yard of woven cloth by multiplying the picks per inch in the loom by the *loom width* and dividing the result into proportionate parts according to the filling pattern.

Picks per inch in loom, 54. Loom width, 29.15 inches.

54 x 29.15 = 1574.1 yards of filling in one yard of cloth in loom.

This divided by the number of picks in one repeat of the filling pattern = patterns of filling in one yard of woven cloth in loom.

1574 1 ÷ 18 = 87.45 patterns of filling.

Multiplying the number of picks of each color in one pattern by the number of patterns = number of yards of each color of filling in one yard in loom.

White,	4 x 87.45 =	349.8 yards.
Yellow,	4 x 87.45 =	349.8 yards.
Black,	8 x 87.45 =	699.6 yards.
Red,	2 x 87.45 =	174.9 yards.
		1574.1 yards.

(*c*). Find the weight in pounds of each color by dividing the respective lengths by the number of yards of filling yarn in one pound.

Yards of filling yarn in one pound, 20235.6.

White,	349.8 ÷ 20235.6 =	.0173 pounds.
Yellow,	349.8 ÷ 20235.6 =	.0173 pounds.
Black,	699.6 ÷ 20235.6 =	.0345 pounds.
Red,	174.9 ÷ 20235.6 =	.0086 pounds.
		.0777 pounds.

(*d*). Find the weight in ounces of each color by multiplying the weight in pounds of each color by the number of ounces in one pound.

Ounces in 1 pound, 16.

White,	.0173 x 16 =	.2768 ounces.
Yellow,	.0173 x 16 =	.2768 ounces.
Black,	.0345 x 16 =	.5520 ounces.
Red,	.0086 x 16 =	.1384 ounces.

The filling take up has been considered in the width in loom, therefore the above weights give the weight of each color of filling yarn in one yard of woven cloth in the loom.

FORMULA: (Picks per inch x loom width) ÷ picks in pattern = patterns of filling in one yard in loom.

54 x 29.15 ÷ 18 = 87.45 patterns.

(Patterns of filling x picks of each color in pattern x ounces in one pound) ÷ (counts by standard number) = weight in ounces of each color of filling in one yard of woven cloth in loom.

White,	87.45 x 4 x 16 ÷ 24.09 x 840 =	.276 ounces.
Yellow,	87.45 x 4 x 16 ÷ 24.09 x 840 =	.276 ounces.
Black,	87.45 x 8 x 16 ÷ 24.09 x 840 =	.553 ounces.
Red,	87.45 x 2 x 16 ÷ 24.09 x 840 =	.138 ounces.
		1.243 ounces.

20. Weight of one yard of cloth in loom.

The weight of one yard of cloth in the loom is found by adding the total weights of warp (including take up) in question 18 and filling in question 19.

Weight of warp,	1.810 ounces.
Weight of filling,	1.243 ounces.
	3.053 ounces.

PROOF: To prove the weight of one yard of cloth in the loom find the weight of one yard of cloth according to the finished data, substituting the finished width including selvedges for the finished width.

27.5 x 36 x 1.35 ÷ 437.5 = 3.054 ounces.

CLOTH ANALYSIS.

Date, September 1, 1905. *Name,* Charles Moody.

Pattern No. 103 X

Fabric, Cotton Gingham.

Data: one square inch = 1.35 *grains.* *Width within selvedges, finished,* = 36 inches.

64 *Threads per inch finished* = .8 *grains.* 54 *Picks per inch finished* = .55 *grains*

Total warp ~~shrinkage~~ take up, 8% *In weaving,* —— *In finishing,* ——

Total filling ~~shrinkage~~ take up, 7% *In weaving,* —— *In finishing,* ——

Add, for selvedge, to finished width, ½ inch = 32 white *threads.*

Remarks,

ANALYSIS.

1. *Weight of one yard inside selvedges,* 36 × 36 × 1.35 ÷ 437.5 = 3.999 ounces.
2. *Pick out,* Plain weave
3. *Drawing in draft and chain,* 2 harnesses.
4. *System or dressing of warp,*

					Total	
Black	4	4			8	
Red			2		2	
White				2 2	4	
Yellow				4	4	18

5. *System or scheme of filling,*

Same as the warp.

6. *Threads in warp,* 36 × 64 = 2304. 7. *Threads in pattern,* 18 8. *Patterns in warp,* 2304 ÷ 18 = 128.

9. *Size, (counts, or run,) of warp in finished cloth,*
64 × 7000 ÷ .8 × 36 × 840 = 18.518

10. *Size, (counts, or run,) of filling in finished cloth,*
54 × 7000 ÷ .55 × 36 × 840 = 22.727

11. *Weight of warp yarn in one yard of finished cloth,*
64 × 36 × 16 ÷ 18.518 × 840 = 2.369 ounces

12. *Weight of filling yarn in one yard of finished cloth,*
54 × 36 × 16 ÷ 22.727 × 840 = 1.630 ounces 3.999 oz.

RECONSTRUCTION.

13. *Width in loom, including selvedges,* 36 + .5 = 36.5 × 1.07 = 39.055 inches.
14. *Reed,* 36.5 × 64 = 2336 ÷ 39.055 = 59.81 threads per inch in loom. 59.81 ÷ 2 = 29.9 reed.
15. *Approximate size of original warp yarn, i. e. in loom,* 18.518 × 1.08 = 19.999
16. *Approximate size of original filling yarn, i. e. in loom,* 22.727 × 1.07 = 24.317
17. *Picks per inch in loom,* 54
18. *Weight of each color of warp yarn in loom, including selvedges,*

Black 128 × 8 = 1024	Black	1024 × 16 ÷ 19.999 × 840 = .975 × 1.08 =	1.053 oz.
Red 128 × 2 = 256	Red	256 × 16 ÷ 19.999 × 840 = .244 × 1.08 =	.263 "
White 128 × 4 = 512 + 32 = 544	White	544 × 16 ÷ 19.999 × 840 = .518 × 1.08 =	.559 "
Yellow 128 × 4 = 512	Yellow	512 × 16 ÷ 19.999 × 840 = .488 × 1.08 =	.527 "

19. *Weight of each color of filling yarn in loom, including selvedges,*

39.055 × 54 = 2108.97 ÷ 18 = 117.17	Black	117.17 × 8 × 16 ÷ 24.317 × 840 =	.734 "
	Red	117.17 × 2 × 16 ÷ 24.317 × 840 =	.184 "
	White	117.17 × 4 × 16 ÷ 24.317 × 840 =	.367 "
	Yellow	117.17 × 4 × 16 ÷ 24.317 × 840 =	.367 "

20. *Weight of one yard of cloth in loom,* 36.5 × 36 × 1.35 ÷ 437.5 = 4.054 ounces
Proof, Warp 1.053 + .263 + .559 + .527 = 2.402
Filling .734 + .184 + .367 + .367 = 1.652 4.054 ounces.

CLOTH ANALYSIS

Date, October 1, 1906. Name, Charles Moody.

Pattern No. 404 S

Fabric, Woolen Suiting.

Data: one square inch= 3.6 grains. Width within selvedges, finished,= 56 inches.

57 Threads per inch finished= 2.1 grains. 52 Picks per inch finished= 1.5 grains

Total warp, 26.4% In weaving, 6% In finishing, 20%

Total filling, 15%

Add, for selvedge, to finished width, 1 inch = 56 black threads.

Remarks,

ANALYSIS

1. Weight of one yard inside selvedges, 56 x 36 x 3.6 + 437.5 = 16.588 ounces.
2. Pick out, 4 x 4. Cassimere twill. 3. Drawing in draft and chain, Straight on 4. 4 bars.
4. System or dressing of warp,

Black woolen	11	11	22
White woolen	2		2
			24 threads in pattern

5. System or scheme of filling,
Black woolen solid

6. Threads in warp, 57 x 56 = 3192 7. Threads in pattern, 24 8. Patterns in warp, 3192÷24 =133
9. Size, (counts, or run,) of warp in finished cloth,
57 x 7000 ÷ 2.1 x 36 x 1600 = 3.298 run

10. Size, (counts, or run,) of filling in finished cloth,
52 x 7000 ÷ 1.5 x 36 x 1600 = 4.213 run

11. Weight of warp yarn in one yard of finished cloth,
First formula; 57 x 56 x 16 ÷ 3.298 x 1600 = 9.678 ounces.
Second formula; 57 x 56 ÷ 329.8 = 9.678 ounces.

12. Weight of filling yarn in one yard of finished cloth,
First formula; 52 x 56 x 16 ÷ 4.213 x 1600 = 6.911 ounces.
Second formula; 52 x 56 ÷ 421.3 = 6.911 ounces.

RECONSTRUCTION.

13. Width in loom, including selvedges, (56 plus 1) ÷ .85 = 67.058 inches.
14. Reed, 57 x 57 = 3249 ÷ 67.058 = 48.45 ÷ 4 = 12.11 12/4 reed.
15. Approximate size of original warp yarn, i. e. in loom,
3.298 ÷ .736 = 4.480 run.

16. Approximate size of original filling yarn, i. e. in loom,
4.213 ÷ .85 = 4.956 run.

17. Picks per inch in loom, 52 x .80 = 41.6
18. Weight of each color of warp yarn in loom, including selvedges,
Black woolen 133 x 22 = 2926 + 56 = 2982 ÷ 448 = 6.656 ÷ .92 = 7.234 oz
White woolen 133 x 2 = 266 ÷ 448 = .593 ÷ .92 = .644 oz
7.249 7.878 oz

19. Weight of each color of filling yarn in loom, including selvedges,
Black woolen 67.058 x 41.6 ÷ 495.6 = 5.628 ounces

20. Weight of one yard of cloth in loom, Warp weight 7.878 ounces
Filling weight 5.628 ounces
13.506 ounces ÷ .80 = 16.882 oz

Proof; 67 x 57 x 3.6 ÷ 437.5 = 16.885 oz